



Sorensen

DCR-A SERIES

**3 Phase
Power Supplies**

Instruction Manual

Manual covers DCR-A models:

20-250	40-500A1
20-500	150-35
20-1000	150-70
20-1000A1	300-18
40-125	300-35
40-250	600-18
40-500	

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SECTION 1

GENERAL INFORMATION

1.1 INTRODUCTION

This manual contains operation and maintenance data on the DCRA three phase input power supply series manufactured by Sorensen 9250 Brown Deer Road, San Diego CA 92121-2294.

It is intended to familiarize the user with the functioning of the unit, indicate the various applications of the unit, and to furnish maintenance information.

The manual is divided into six sections. The first is an introduction and general description of the series, along with complete unit specifications and performance curves. Section 2 lists procedures to be followed upon initial receipt of the instrument, and procedures for modifying the unit for alternate input voltages.

Section 3 presents a listing of front panel indicators and controls as well as a brief description of their function. Operating instructions, including procedures for adapting the unit to a number of varied applications are also included. Section 4 is theory of operation, and Section 5 gives troubleshooting, repair, and calibration information. Replacement parts lists and schematics are in Section 6, and optional overvoltage protection accessories are covered in Appendix A.

1.2 DESCRIPTION

The DCRA series are designed for either rack or floor mounting, and provide stable, highly regulated dc outputs from a wide range of three phase input voltages and frequencies. (For complete unit specifications refer to Table 1-2.) The series all exhibit excellent transient response and low ripple in both voltage regulating and current limiting modes. Other design features include provisions for remote programming, remote sensing, and series and parallel operation. Increased versatility is also provided by use of a floating neutral, which permits use of either three or four wire input.

1.2.1 Automatic Crossover

The automatic crossover system allows the unit to transfer operating modes as a function of load requirements. As an example, if current output is set for 20% of full scale current, and load requirements are greater than this value, the unit will transfer operation automatically from a voltage regulating to a current limiting mode. In this mode, the current will be held to the 20% level selected. If load requirements are lowered or if the current limiting value is raised by the front panel mounted current adjust control, transfer to the voltage regulating mode will occur automatically.

In the crossover transfer region, voltage and current mode regulation deteriorates as shown in Figure 1-1. (For example, assume a full scale current rating of 70A. If the current limit value is set for 14A, the voltage mode regulation begins to deteriorate when the load current exceeds 7 amps. This occurs at the point labeled I_{sc} minus 7A, or in this example, 14A minus 7A. The current mode regula-

tion begins to deteriorate when the output voltage exceeds 3 volts (6V minus 3V).)

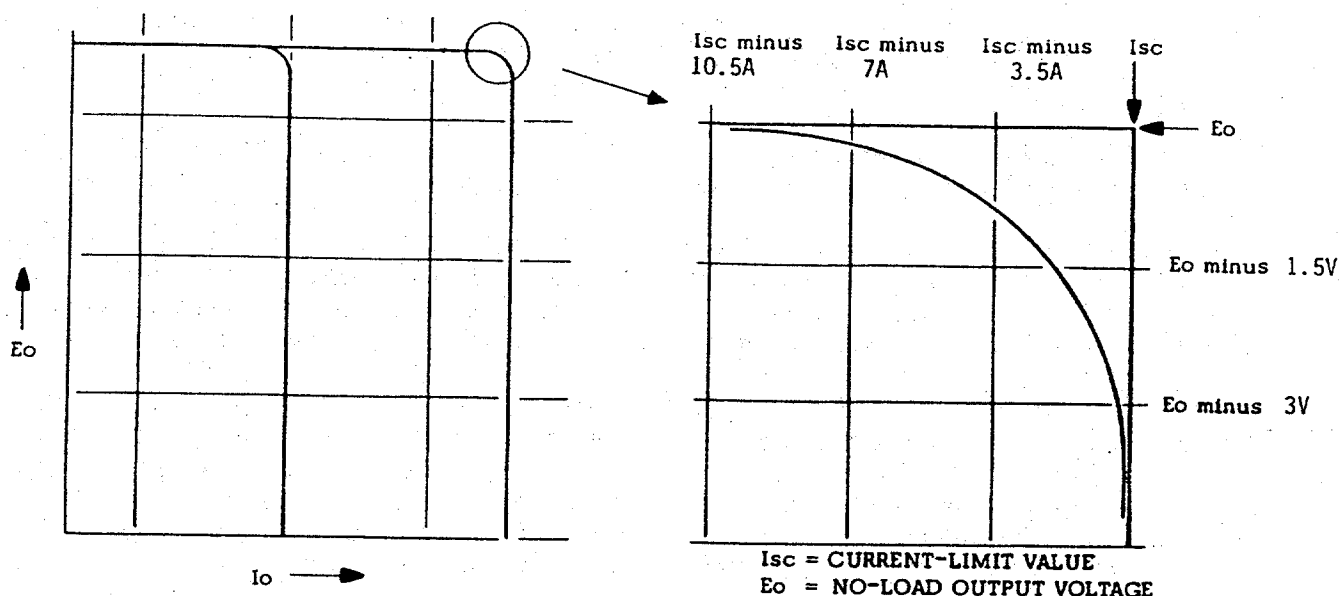


Figure 1-1 Crossover Characteristics

1.2.2 Remote Programming

The power supplies may be remote programmed in either of two modes: voltage or resistance. This feature permits the adjustment of output voltages or currents to preset values from remote locations.

1.2.3 Remote Sensing

To allow for voltage drop in the load lines, a remote sensing system has been designed into the power supply. This system monitors the unit output voltage to assure that the selected voltage is being delivered to the load and not simply across the unit output terminals. The maximum drop for which the unit will compensate is 3 volts per line.

1.2.4 Series Operation

Some applications require a higher output voltage than that for which the unit is designed. To meet the demands of these applications, the power supplies are designed to operate in series. The lower voltage units, (i.e.) 20 and 40 volts,

may have as many as five units in series, while the higher voltage series, 150 and 300 volts, are restricted to two. The 600 volt model may not be connected in series configuration.

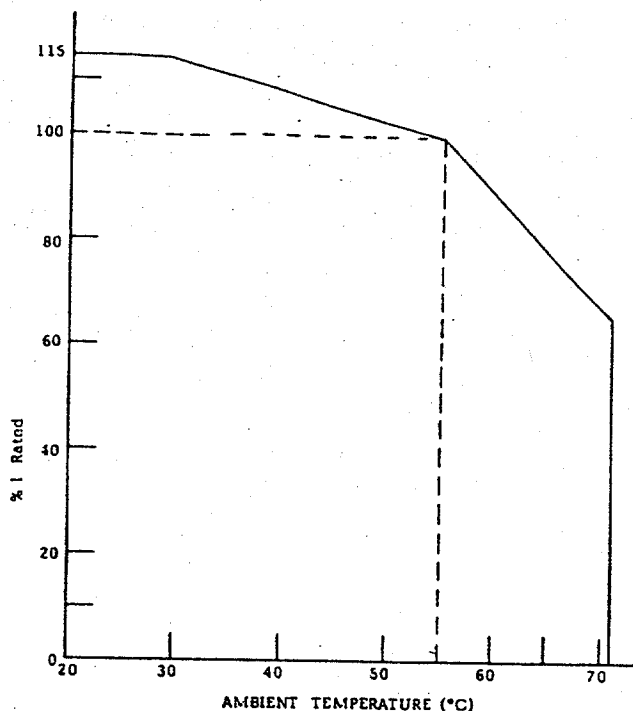


Figure 1-2 Current Derating Characteristics

1.2.5 Parallel Operation

Like series operation, parallel operation permits the unit to be used in applications where output requirements are above those for which the unit is designed. As many units as desired may be placed in parallel. Some loss of regulation will occur for each unit, however. (Refer to Section 3).

1.2.6 Failure Protection

In addition to the current limiting protection provided by automatic crossover and the current regulator, the supplies incorporate two other protection systems. One drops the output to zero and energizes a light on the control panel if there is a loss of one input phase, and the other, thermal overload, usually resulting from a cooling fan failure, will also drop the output to zero and energize an indicator lamp.

1.2.7 Optional Equipment

1.2.7.1 **Auxiliary Chassis** - A three phase autotransformer is offered as an optional item on models 20-250, 40-125, 150-35 and 300-18, to increase their flexibility. With this accessory, three-phase inputs of 342-418 V, 390-440 V, or 414-

560 V may be used. The transformer is installed in a specially designed chassis so that, if desired, the chassis may be mounted to the DCR supply. Particulars on the transformer are listed in Table 1-1.

1.2.7.2 Rear Support Kit - This consists of two angle brackets which, when rack mounting a unit, are installed on the vertical members of the rack to guarantee adequate support.

1.2.7.3 Cover Kit - A kit designed to add to the decorative appearance of the unit. It includes two side covers and the required hardware for attachment.

1.2.7.4 Caster Kit - This optional item, when installed, allows the unit to be moved easily from place to place. It consists of four swivel type casters, two of which have braking mechanisms.

Table 1-1 Optional Equipment

<u>ITEM</u>	<u>PART NO.</u>	<u>DESCRIPTION</u>
Auxiliary Chassis	195-2184 Model ST 101	3 phase autotransformer Input Voltage: 380 V/50-63 Hz Input 415 V/50-63 Hz Input 460 V/50-63 Hz Input Input Current: 380 V 22 A Max. 415 V 22 A Max. 460 V 19 A Max. Output Voltage: 187-229 V AC (380 V Input) 207-253 V AC (415 or 460 V Input) Output Current Range: 0-37 A AC Cooling: Convection Dimensions: Width 19 in. (483 mm) Height 7 in. (178 mm) Depth 22 in. (559 mm)
Support Kit	190-3674	Heavy duty angle brackets to help support rack mounted units.
Caster Kit	190-3675	Four casters to give unit mobility. Two support brackets. 16 screws and washers.
Cover Kit	190-3677* 190-3679*	Two side covers for decorative purposes. 8 to 16 screws.
Overvoltage Protector		See Appendix A

*Kit 190-3677 is for units without auxiliary chassis; for units with auxiliary chassis, use kit 190-3679.

SECTION 2

INSTALLATION

2.1 GENERAL

After unpacking, general inspection and preliminary checkout procedures should be performed to assure that the unit is in proper working order. These consist of visually inspecting for physical damage and performing an electrical check. If it is determined that the unit is damaged, the carrier should be notified immediately. The carrier's claim agent will prepare a report of damage, which should be sent to the Repair Department, SORENSEN 9250 Brown Deer Road San Diego, CA 92121-2294. Sorensen will advise the user as to the action required to repair or replace the supply. Written approval from Sorensen must be obtained before the unit is returned for repair.

2.2 INSPECTION

Proceed as follows to inspect for damage incurred during shipment.

- a. Check meter faces for cracked or broken glass. Check each meter for zero indication. Use zero adjust to bring indicator to zero, if necessary.
- b. Look for cracked or broken lenses on the indicator lights.
- c. Rotate the FINE and COARSE VOLTAGE ADJUST and CUR. ADJ. AMPS potentiometers. Knobs should turn smoothly through 300 degrees.
- d. Test for positive action of circuit breaker by operating it a few times. Set breaker to OFF position.
- e. Detach side panels, and inspect for loose connections and structural damage.
- f. Remove front-panel retaining screws, located on either side of unit, and gently separate panel a few inches from chassis to allow internal inspection. Check tightness of screw type connections at the transformer and silicon-controlled rectifier board. Reinstall panel using screws originally removed.
- g. Remove rear panel, and inspect for loose connections. Make sure that the links and wires on terminal board TB2, located at the upper right-hand side of the input panel, are securely fastened. Refer to Figure 3-2 for TB2 details. Reinstall panel.

If any optional equipment (refer to Table 1-1) has been purchased with the unit, assure that all parts are accounted for and that no damage has occurred in shipment. (Optional parts are normally shipped loose in the packaging carton.)

2.3 OPTIONAL EQUIPMENT INSTALLATION

The unit is shipped in ready to use condition. If optional accessories have been purchased, however, they must be installed at destination. The following sections detail the installation of optional equipment.

2.3.1 Auxiliary Chassis

The auxiliary chassis may be mounted below the main chassis or remotely located as desired. To mount the chassis proceed as follows:

NOTE

The following procedure is more easily accomplished if an overhead lifting device of sufficient capacity to lift and hold the unit while mounting the chassis is available.

- a. Remove front and rear panels on auxiliary chassis. Mounting hardware is located on either side of panels.
- b. Remove bag from right-hand handle, and remove two spacers and screws.
- c. Using the eye hooks at the top of the unit and an overhead lifting device, raise the unit about 10 inches from the floor.
- d. Detach feet from the bottom of the main unit and reinstall beneath auxiliary chassis.
- e. Place one spacer on the forward bracket which runs laterally across the top of the unit and align the holes in both spacer and bracket. Repeat procedure for the other spacer and bracket at the rear of the unit.
- f. Insert one screw up through a bracket and spacer and then use the screw as a hole aligning guide when lowering the main chassis onto the auxiliary.

2.3.2 Caster Kit

Install the casters as follows:

- a. Raise the unit off the floor until the feet are sufficiently exposed to allow removal and remove them.
- b. Mount casters to support brackets and align brackets over holes vacated by the removal of the feet. Attach with the hardware provided.

NOTE

The two casters with braking mechanisms are to be mounted over the forward holes.

2.3.3 Support Kit

Mount the left and right hand angle brackets to the rear vertical rack channels at an elevation which ensures cradling of the unit.

2.4 MECHANICAL INSTALLATION

The unit is shipped ready for floor use. With the exception of the 20-1000 and 40-500 models, which must be floor mounted, rack mounting is possible. If the unit is to be rack mounted, eye hooks at the top and feet below the unit must be removed. As these power supplies have a relatively large mass, they should be mounted at or near the bottom of the rack. If one of the three phase inputs other than that supplied is to be used, make the necessary wiring changes prior to installation.

2.5 GENERAL PRECAUTIONS

WARNING

This unit requires a 3-pole, wall-mounted, fused disconnect switch for safe installation. DO NOT turn on wall switch until AC and DC wires are attached to DCR-A unit and rear cover plate is in place. Accidental shorts or hand contact inside the DCR-A terminal box can cause burns or electrical shock.

Follow These Steps In Wiring:

1. Check phase rotation at the wall switch (see manual). Mark terminals 1 - 2 - 3 to correspond.
2. Identify the proper safety ground at the wall switch. (The neutral or a separate ground wire may be provided. Check the power company for the proper connection.)
3. Label four wires for the input connection: Wires 1 - 2 - 3 are connected to the 3-phase terminals, and wire 4 is connected to the safety ground terminal.
4. Connect the 4-wires to the DCR-A ac input terminals which are marked 1 - 2 - 3 ground.

IMPORTANT SAFETY PRECAUTION

Wire 4 must be connected to the CHASSIS GROUND terminal to provide a ground for the DCR-A chassis frame.

5. Connect the two DC output wires. Label (+) and (-).
6. Replace the DCR-A cover plate over the ac/dc terminals before applying input power from the wall switch.

2.6 ELECTRICAL INSTALLATION: MODELS 20-250, 40-125, 150-35 and 300-18

The above units are shipped wired to accept a 208 volt, three phase input. If either a 230, 380, 415, or 460 volt input is to be used, minor alterations must be made to the transformer wiring.

NOTE

An auxiliary chassis (See Table 1-1) must be used if unit is to accept either 380, 415 or 460 volt input.

CAUTION

Read wiring Caution on page 2-3 before starting wiring. Unit is phase rotation sensitive. Test input phase per para. 2-9.

2.6.1 208 Volt Input

For a 208 volt input, simply connect the input leads to terminals 1, 2, 3 (and GRD for a 4 wire input) on terminal board TB1 (INPUT) located at the bottom center of the rear panel.

2.6.2 230 Volt Input

To adapt unit for a 230 volt input, disconnect the yellow wire at tap 3 of transformer T5 (located immediately above terminal board TB1 (INPUT) on the rear panel) and reconnect at terminal 4 of the same transformer. Then connect the input leads as in paragraph 2.6.1. See Figure 2-1 for T5 tapping arrangement.

2.6.3 460 Volt Operation

The unit is not designed to accept other than 208 or 230 volt inputs. However, the optional auxiliary chassis may be used to convert the input to 460 volt operation. This chassis is factory wired for a 460 volt input and 230 volt output. In wiring the chassis, first adapt the main unit for a 230 volt input per paragraph 2.6.2. Test chassis input phase rotation (paragraph 2.9); then check chassis to unit rotation.

2.6.4 415 and 380 Volt Operation

The optional auxiliary chassis is used to convert the unit to 415 volt operation.

- a. The auxiliary chassis is set up for 460 volt input as supplied, and must be slightly modified for the lower voltage. Relocate the wire at terminal 4 of each of the three transformer primaries to terminal 3 (see Figure 2-2).

- b. The basic unit must be adapted for 230 volt input per para. 2.6.2.
- c. Chassis input phase rotation and chassis to unit rotation must be checked per para. 2.9.

2.6.5 380 Volt Operation

The optional auxiliary chassis is used to convert the unit to 380 volt operation.

- a. Rewire the auxiliary chassis as outlined in para. 2.6.4a.
- b. The basic unit must be wired for 208 volt input (as shipped).
- c. Chassis input phase rotation and chassis to unit rotation must be checked per para. 2.9.

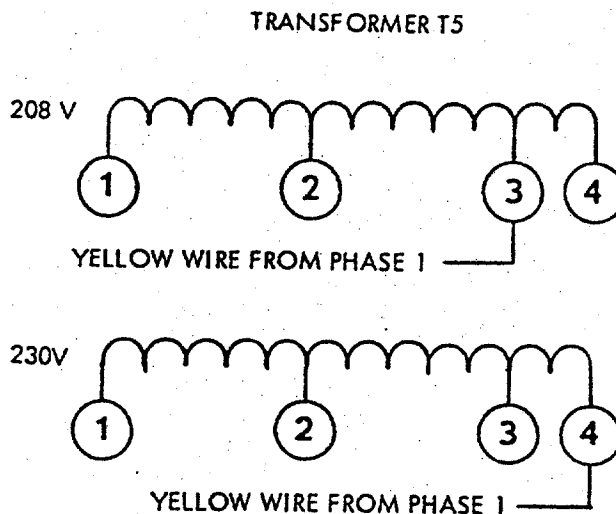


Figure 2-1 Alternate Transformer Connections 20-250, 40-125, 150-35, 300-18

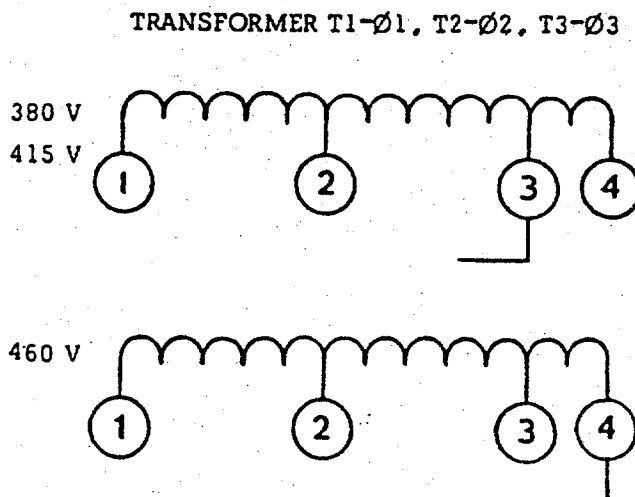


Figure 2-2 Auxiliary Chassis Input Connections 20-250, 40-125, 150-35, 300-18

2.7 ELECTRICAL INSTALLATION: MODELS 20-500, 40-250, 150-70, 300-35,
and 600-18.

The above units are shipped, factory wired, to accept a 460 volt three phase input. However, by making a few wiring changes at transformers T1, T2, T3, T4 and T5, the units may be altered to accept either a 208, 230, 380, or 415 volt input. Transformers T1, T2, and T3 are located behind the front panel on the left-hand side of the unit. Transformer T4 is at the lower left-hand side of the rear panel, and transformer T5 is directly below terminal board (TB2) on the rear panel. Tap numbers are stenciled on the transformers.

NOTE

Units may be operated at 50Hz on the 380 volt and 415 volt taps only.

CAUTION

Read wiring Caution on page 2-3 before starting wiring. Units are phase rotation sensitive. Before connecting input, check rotation per para. 2.9.

2.7.1 208 Volt Operation

To adapt unit from a 460 volt configuration to a 208 volt input, see Figure 2-3 and proceed as follows:

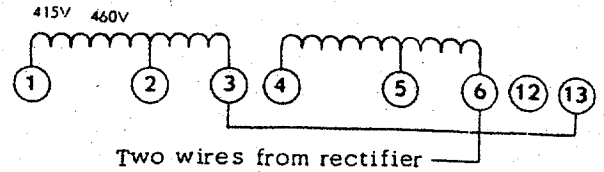
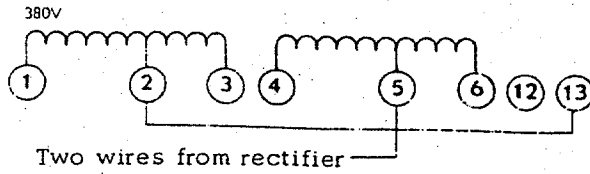
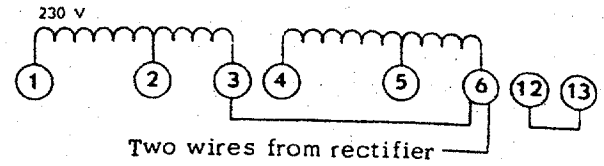
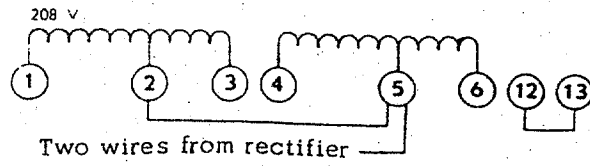
- a. At transformers T1, T2, and T3, move violet wire from tap 6 to tap 5. Unsolder jumper across taps 3 and 13 and reconnect across taps 2 and 5. Solder a jumper across taps 12 and 13.
- b. At transformer T4, remove jumpers across taps 16 and 17, 2 and 3, and 27 and 28. Solder new jumpers across taps 15 and 17, 16 and 19, 1 and 3, 2 and 5, 26 and 28, and 27 and 30.
- c. At transformer T5, move orange wire from tap 8 to tap 7. Unsolder jumper across taps 4 and 5. Connect new jumpers across taps 1 and 5, and 3 and 7.
- d. Check input phase rotation per paragraph 2.9.

2.7.2 230 Volt Operation

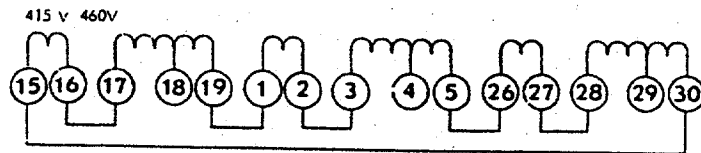
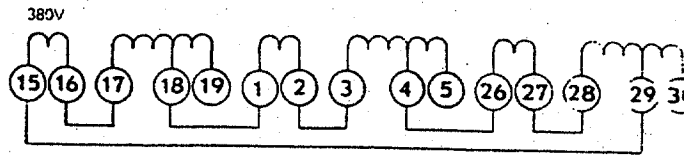
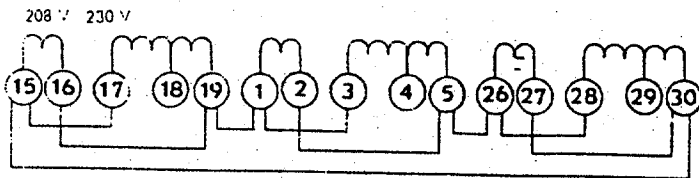
To adapt unit from a 460 volt configuration to a 230 volt input, see Figure 2-3 and proceed as follows:

- a. At transformers T1, T2 and T3, detach the tap 13 end of the jumper between taps 3 and 13, and reconnect to tap 6. Connect a jumper between taps 12 and 13.

TRANSFORMERS T1, T2, and T3



TRANSFORMER T4



TRANSFORMER T5

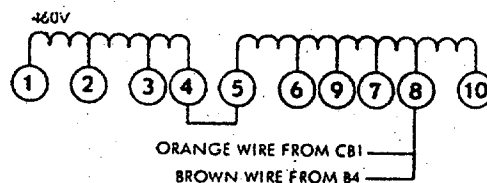
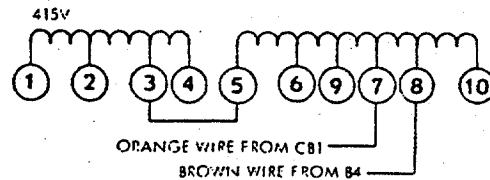
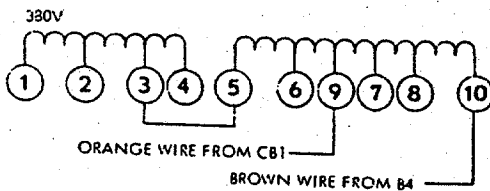
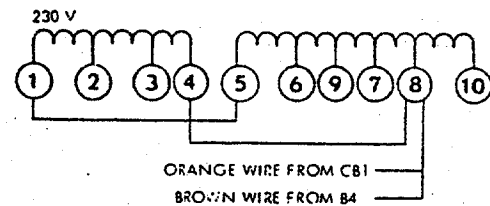
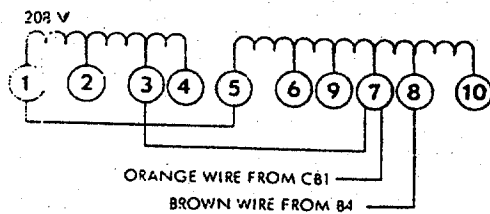


Figure 2-3 Unit Input Connections 20-500, 40-250, 150-70, 300-35, 600-18

- b. At transformer T4, remove jumpers across taps 16 and 17, 2 and 3, and 27 and 28. Solder new jumpers across taps 15 and 17, 16 and 19, 1 and 3, 2 and 5, 26 and 28, and 27 and 30.
- c. At transformer T5, remove jumper across tap 4 and 5. Connect jumpers between taps 1 and 5, and 4 and 8.
- d. Check input phase rotation per paragraph 2.9.

2.7.3 380 Volt Operation (50 Hz)

To adapt unit from a 460 volt configuration to a 380 volt input, see Figure 2-3 and proceed as follows:

- a. At transformers T1, T2 and T3, move violet wire from tap 6 to tap 5. Detach the tap 3 end of the jumper between taps 3 and 13, and reconnect to tap 2.
- b. At transformer T4, relocate jumper at tap 30 to tap 29, jumper at tap 5 to tap 4, and jumper at tap 19 to tap 18.
- c. At transformer T5, unsolder brown wire at tap 8 and reconnect at tap 10. Relocate orange wire at tap 8 to tap 9. Unsolder tap 4 end of the jumper between taps 4 and 5, and reconnect to tap 3.
- d. Check input phase rotation per paragraph 2.9.
- e. Input rating is 342-418 Vac, 50Hz.

NOTE

With a 380 volt input, maximum dc output voltage is 90% of rated output voltage.

2.7.4 415 Volt Operation (50 Hz)

To rewire unit from 460 volt to 415 volt operation see figure 2-3 and proceed as follows:

- a. At transformer T5, relocate orange wire from tap 8 to tap 7. Unsolder tap 4 end of jumper between taps 4 and 5, and resolder to tap 3.
- b. Check input phase rotation per paragraph 2.9.
- c. Input rating is 390-440 Vac, 50Hz.

2.8 ELECTRICAL INSTALLATION: MODELS 20-1000 and 40-500

The above units are shipped, factory wired, to accept either a 460 or 415 volt, three phase input. If a 380 volt input is to be used, minor alterations must be made to transformer wiring.

CAUTION

Read wiring Caution on page 2-3 before starting wiring. Unit is phase rotation sensitive. Check per para. 2.8.

2.8.1 460 or 415 Volt Input*

For a 460 or 415 volt input, connect the input leads to terminals 1, 2, and 3 (and GRD for a four wire input) on terminal board TB1 (INPUT) located at right-hand center of the rear panel.

NOTE

*May be operated at 50Hz on 415 volt input only.

- a. Input rating is 390-440 Vac, 50Hz.
- b. Maximum dc output voltage is derated to 93% of rated voltage.

2.8.2 380 Volt Input (50 Hz)

To alter the units for a 380 volt input see Figure 2-4 and proceed as follows:

- a. At transformer T4, located at the rear of the unit in left-hand wall below center, remove jumpers between taps 15 and 30, 19 and 1, and 5 and 26. Install new jumpers across taps 15 and 29, 18 and 1, and 4 and 26.
- b. On transformer T5, located at underside of the center plate close to the lateral midpoint, unsolder white wire at tap 3 and reconnect it to tap 2.
- c. On transformer T9, located at underside of center plate directly beneath input terminal block TB1, unsolder the green wire from tap 3 and reconnect it to tap 2.
- d. Before connecting input lines, check phase rotation per paragraph 2.9.
- e. Input rating is 342-418 Vac, to 50Hz.

NOTE

With a 380 volt input, maximum dc output voltage is 75% of rated output voltage.

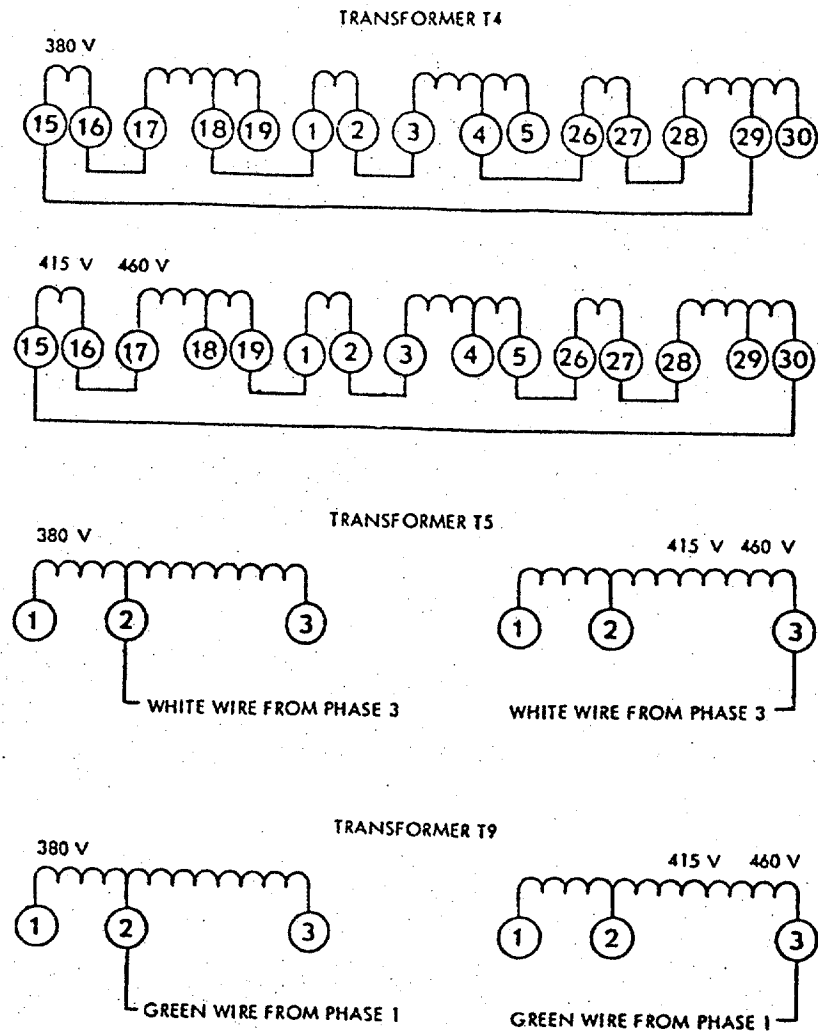


Figure 2-4 Unit Input Connections 20-1000, 40-500

2.9 PHASE ROTATION CHECK

CAUTION

Read wiring Caution on Page 2-3 before starting tests.

The DCR is a phase rotation sensitive unit, with a rotation sequence of 1 - 2 - 3 (with respect to the three ac input terminals marked 1 - 2 - 3).

There are two methods for determining that the DCR has been properly hooked up to the 3-phase line:

Method I is the easiest to implement in that no special equipment is needed.

Method II requires the use of a standard electricians 3-phase rotation meter.

2.9.1 Method 1

With the ac disconnect switch OFF:

1. Connect the 3 wall switch lines 1 - 2 - 3 to the DCR input terminals 1 - 2 - 3, without concern to phase rotation.
2. Close the disconnect switch to apply ac power to the DCR-A.
3. With no load on the DCR-A output, adjust the current panel control to approximately 1/4 of full scale. Adjust the voltage panel control to obtain approximately 10% of rated maximum voltage (e.g., set for 4V on a DCR 40-125A), as read on the panel dc voltmeter.
4. Observe the panel dc voltmeter. If any erratic pulsing or jumping is noticed on the meter, turn off the ac wall disconnect switch to remove ac power from the DCR=A input.
5. Interchange to two ac input wires connected to DCR-A input terminals 1 and 2 on the unit or wall switch terminals, whichever is easier. Discharge input filter capacitors at each input lug to ground before handling the wires.
6. Restore the ac power and recheck per steps 3 and 4.
7. Select the ac wiring which yields a steady dc voltmeter reading.

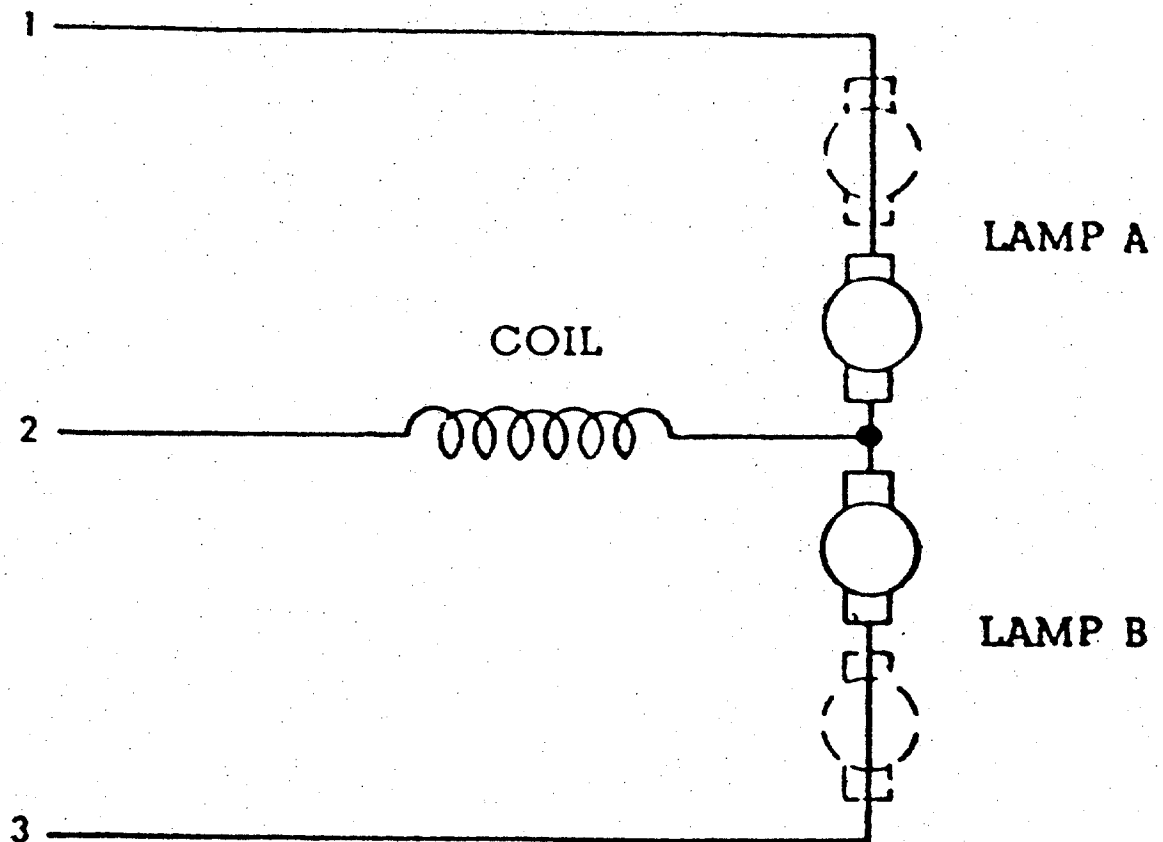
2.9.2 Method II

1. Before connecting the DCR-A ac input terminal to the wall switch, determine the phase rotation at the switch load terminals.

Use a commercial electricians Phase Rotation Meter:

- a. With the switch off, label the three line-to-line load terminals of the switch 1 - 2 - 3 (left to right).
- b. Connect the three rotation meter leads to those three terminals. Close the switch and determine (using the meter instructions) whether the phase sequence is 1 - 2 - 3 (left-to-right). If it is correct, proceed to step d.

- c. If the rotation indicated 3 - 2 - 1, then open the wall switch. Interchange the labels on terminal 1 and 3 so the switch terminals are labeled 3 - 2 - 1 (left to right).
- d. Switch off the power and remove the rotation meter. Connect the DCR-A ac input terminal #1 to switch terminal #1, 2 to 2, 3 to 3.
- e. Close the wall switch. DCR-A is ready to operate.



INPUT	LAMP A	LAMP B	COIL
208 V, 230 V	230 V, 100 W	230 V, 100 W	1 Henry*
380 V, 415 V, 460 V	Two 230 V, 100 W In Series	Two 230 V, 100 W In Series	2 Henry*

* A 10 uF capacitor may be used in lieu of a 1 henry coil for 208 V or 230 V Input. With a 380 V, 415 V, or 460 V input, a 5 uF capacitor may be used as a substitute for the 2 henry coil.

Figure 2-5 Phase Rotation Test Set-Up

2.10 INITIAL CHECKOUT

2.10.1 Voltage Mode

To perform a check of voltage mode operation, proceed as follows:

- a. Assure that proper input connections have been made. Refer to previous sections 2.6, 2.7, 2.8, and 2.9.
- b. Turn COARSE and FINE VOLTAGE ADJUST and CUR. ADJ. AMPS controls fully counterclockwise.

NOTE

See Figure 3-1 for location of controls and indicators.

- c. Set unit circuit breaker to ON.
- d. Turn COARSE VOLTAGE ADJUST control slowly clockwise and observe the unit voltmeter. The pointer should move upscale.
- e. With a setting of 50% indicated on the meter, turn FINE VOLTAGE ADJUST from stop to stop. Range should be about 5%.
- f. Set circuit breaker to OFF position.

2.10.2 Current Mode

To check operation of the unit in the current mode, proceed as follows:

- a. Turn FINE and COARSE VOLTAGE ADJUST and CUR. ADJ. AMPS controls fully counterclockwise.
- b. Connect a heavy gauge wire across the output terminals. One of the intended output leads is recommended for this purpose.
- c. Set unit circuit breaker to ON.
- d. Rotate FINE VOLTAGE ADJUST control about 30° from the left hand stop and observe output meters. Ammeter should indicate 0 amps, and voltmeter a fraction of a volt.
- e. Rotate FINE VOLTAGE ADJUST. control fully clockwise.
- f. In small increments, raise CUR. ADJ. AMPS control to about 40% while observing ammeter. Ammeter should read output current equal to that set on the control.
- g. Set unit circuit breaker to OFF.
- h. Remove shorting wire from output terminals.

SECTION 3

OPERATION

This section provides a tabular listing of the unit's controls and indicators, along with a brief description of their function. The physical location of the controls and indicators is shown in Figure 3-1.

Table 3-1 Controls and Indicators

<u>CONTROL/INDICATOR</u>	<u>FUNCTION</u>
COARSE VOLTAGE ADJUST	A 3K ohm potentiometer across which the reference voltage for voltage-mode operation is developed. Used to adjust the output voltage from zero to full scale.
FINE VOLTAGE ADJUST	A 150 ohm potentiometer connected in series with the COARSE VOLTAGE ADJUST potentiometer and used to make vernier adjustments in the output voltage.
CUR. ADJ. AMPS	A 150 ohm potentiometer used in the first stage of the current mode amplifier to vary the reference and subsequently the output current from zero to full scale.
CURRENT MODE Indicator	A green light which, when lighted, indicates that the unit is operating in the current regulating mode.
Unit Circuit Breaker	A three pole circuit breaker (250V, @ 40A for 20-250, 40-125), (460V, @ 35A for 20-500, 40-250), and (460V @ 65A for all others) wired between the input terminal board and the main transformer. Used to connect, or disconnect, incoming power to, or from, the unit, and to protect the unit in the event of internal failure.
POWER ON Indicator	A red light, connected across the secondary of transformer T4 in models 20-1000, 150-70, and 300-35, and T5 in all others, which, when lighted indicates that the circuit breaker is closed and that at least one phase of input is being supplied to the main transformer.
PHASE FAILURE Indicator	An amber light which, when lighted, indicates a failure of a phase of input power. This type of failure will drop output automatically to zero.

Table 3-1 Controls and Indicators (Cont'd)

<u>CONTROL/INDICATOR</u>	<u>FUNCTION</u>
THERMAL OVERLOAD Indicator	An amber light which, when lighted, indicates unit is overheated. A thermal failure causes an automatic drop to zero output.
Unit Ammeter	An ammeter connected in the positive leg of the unit output. Indicates output current.
Unit Voltmeter	A voltmeter connected internally across the SENSE terminals of terminal board (TB2) to give an indication of unit voltage output.

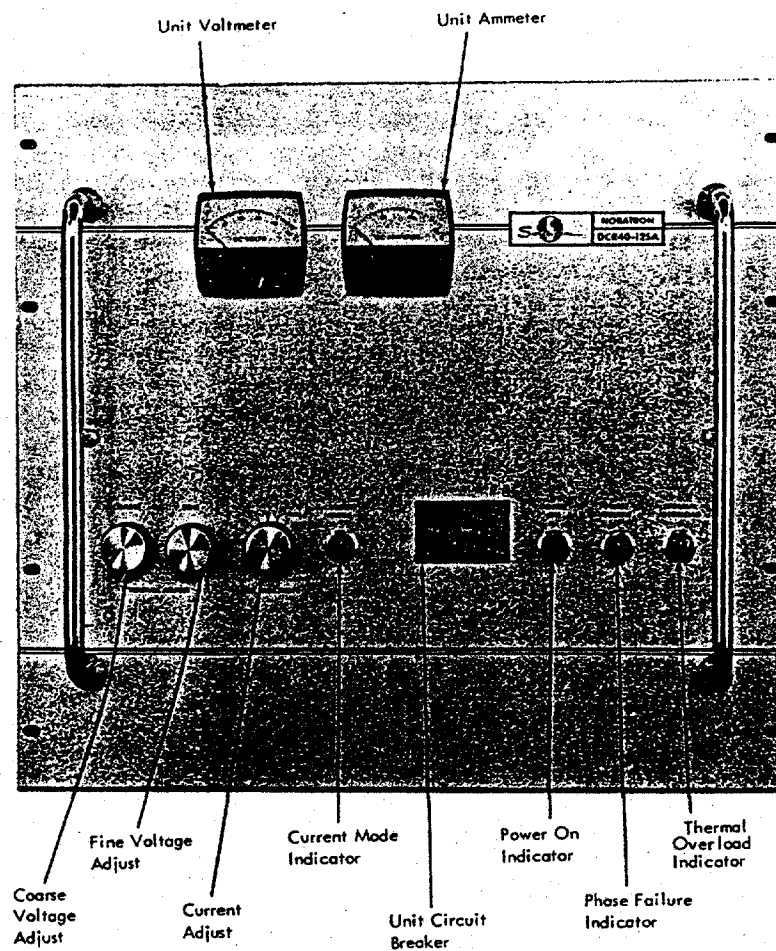


Figure 3-1 Typical Controls and Indicators. (Model DCR40-125A shown)

3.1 GENERAL

This section provides instructions for adapting the supplies to many of their varied applications. Included are procedures to be followed for conversion to: remote sensing operation, voltage, current, and resistance programming modes, and series and parallel operation.

NOTE

Throughout the following discussion, voltage and current levels will be expressed in percentages of full scale label values. This is necessary due to the large variety of outputs available in the DCRA Series. Full scale label values are determined by the model number (e.g.) DCR 40-250A is 40 volts and 250A full scale, 150-35A is 150V and 35A, etc.

3.2 LOCAL SENSING

The supplies are shipped ready for use in the local sensing mode. This simply means that the sensing circuit is connected across the unit output terminals and not at the load. For applications where the voltage drop in the lines is prohibitive, use remote sensing (paragraph 3.5). Figure 3-2 illustrates the local sensing configuration of terminal board TB2.

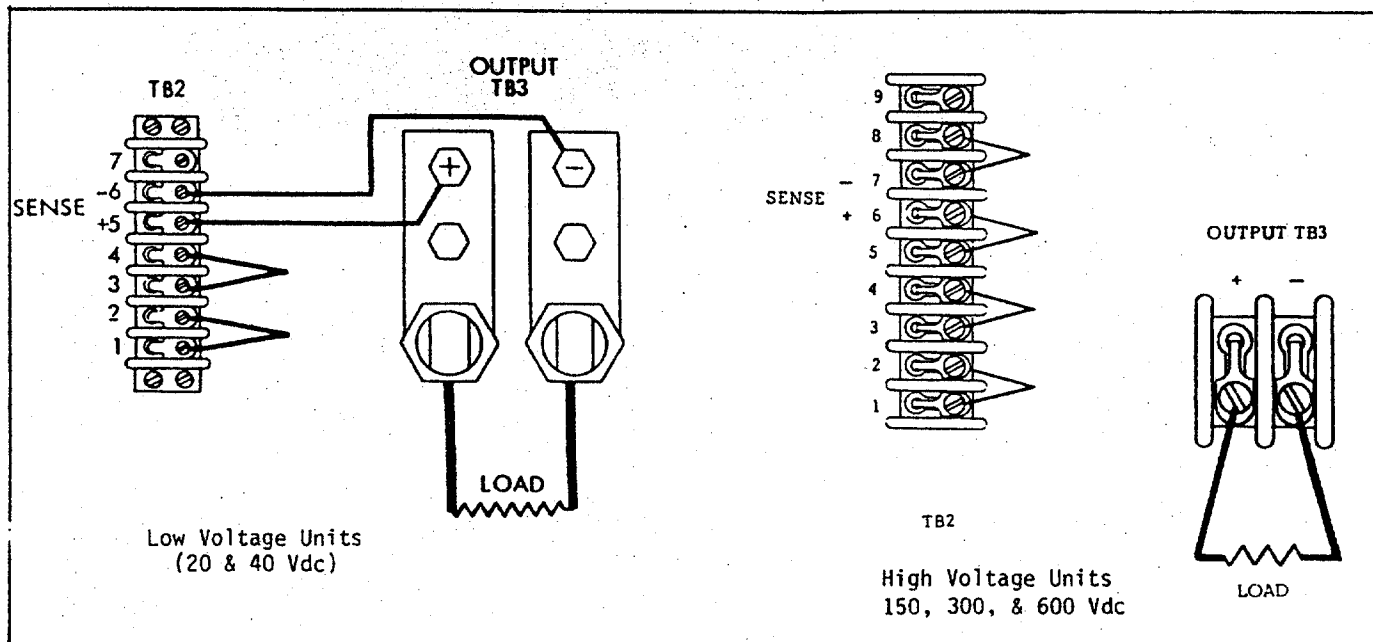


Figure 3-2 Local Sensing Configuration

3.3 VOLTAGE MODE

To put the unit in voltage mode operation, proceed as follows:

- a. Rotate the FINE and COARSE VOLTAGE ADJUST, and CUR. ADJ. AMPS potentiometer fully counterclockwise.
- b. Connect the three-phase input leads as indicated under paragraph 2.5.
- c. Set unit circuit breaker to ON. POWER ON indicator should light.
- d. Rotate COARSE VOLTAGE ADJUST until the unit voltmeter indicates the desired output voltage. Final vernier adjustments may be made with the FINE VOLTAGE ADJUST control.

NOTE

To prevent random firing of the SCR, for voltage outputs below 5% of maximum rated output voltage, it is recommended that a bleeder resistor be connected across the output of sufficient value to draw approximately 10% of rated output current. For example, for a DCR 40-250A below 2 volts use a bleeder to draw approximately a 25A load. This would be approximately .1 ohm (use a 100 watt rating).

- e. Set unit circuit breaker to OFF.
- f. Connect load lines to unit output terminals on terminal board TB3.
- g. Set CUR. ADJ. AMPS control to a value at least 10% above the actual load current.

NOTE

Regulation falls off if output current is within 10% of limiting value. Current mode indicator begins to glow when current output is within approximately 15% of limiting value.

- h. Set unit circuit breaker to ON. POWER ON lamp will light, and the unit is in voltage mode operation.

NOTE

With the unit in the voltage mode, an increase in load current requirements above the value set in step g above will cause an automatic crossover to current mode (current limiting) operation.

3.4 CURRENT MODE

To operate unit in the current mode, proceed as follows:

- a. Rotate the FINE and COARSE VOLTAGE ADJUST and CUR. ADJ. AMPS controls fully counterclockwise.
- b. Connect three phase input as indicated in paragraph 2.5.
- c. Set unit circuit breaker to ON.
- d. Rotate COARSE VOLTAGE ADJUST until unit voltmeter indicates a level 10% above the desired dynamic voltage.

NOTE

Current regulation falls off if the dynamic (compliance) voltage is within 5% of voltage limiting value.

- e. Set unit circuit breaker to OFF.
- f. Connect load lines to unit output terminals on terminal board (TB3).
- g. Set unit circuit breaker to ON.
- h. Turn CUR. ADJ. AMPS control to desired current regulating value. CURRENT MODE lamp lights, and unit is in current mode operation.

NOTE

If compliance (dynamic) voltage rises above limit set in step d, the unit automatically crosses over to voltage mode operation. (Current mode light goes off).

3.5 REMOTE SENSING

A few link changes at the rear panel and alterations at the load terminations of the output leads are all that are required to convert the unit to remote sensing operation. In this mode, voltage regulation is at the load rather than at the unit output terminals, thus correcting for voltage drops in the load lines.

NOTE

A 3 volt drop per line is the maximum for which remote sensing will compensate. To avoid exceeding the rated maximum unit voltage, the maximum load voltage (as read on the panel voltmeter) must be less than the rated maximum by the total of the line drops. i.e., if each load line drops 3 volts (or 6 volts total), then on a 40 volt rated unit (e.g., DCR 40-125A), the voltmeter reading must not exceed $40 - 6 = 34V$.

To adapt unit for remote sensing operation, proceed as follows:

- a. Set unit circuit breaker to OFF.
- b. Remove local sensing leads or links at the plus and minus SENSE of board (TB2). See Figure 3-3.

WARNING

When the unit is returned to operation, the loose ends of the local sensing leads will be HOT. To prevent the possibility of injury to personnel, tape lead ends individually and fold back from both the output terminal board (TB3) and the control terminal board (TB2). (See Figure 3-3).

- c. Tightly secure remote sensing leads to plus and minus SENSE terminals. Note which lead is connected to the plus terminal (remote sensing configuration is shown in Fig. 3-3).

NOTE

Use a twisted or shielded pair of wires for the sensing leads. Sensing current is about 10mA.

- d. Connect the lead from the positive sense terminal to the positive load terminal and connect the other lead at the negative load terminal.
- e. Reset current limit per paragraph 5.3.4.
- f. If the unit is being placed on line for the first time or is being returned to line following a maintenance check, etc., proceed as outlined in paragraph 3.3. Otherwise, set unit circuit breaker to ON. POWER ON indicator will light and the unit supplies load.

3.6 EXTERNAL RESISTANCE PROGRAMMING

3.6.1 Voltage Mode

The unit output voltage may be programmed externally to a predetermined regulated value. This is done by connecting a resistance into the voltage reference circuit of the voltage mode section. Terminals on TB2 are provided for this purpose. (See Figure 3-4).

Voltage programming sensitivity varies according to the full scale voltage output of the unit. Table 1-2 lists the proper ohms/volt for each model.

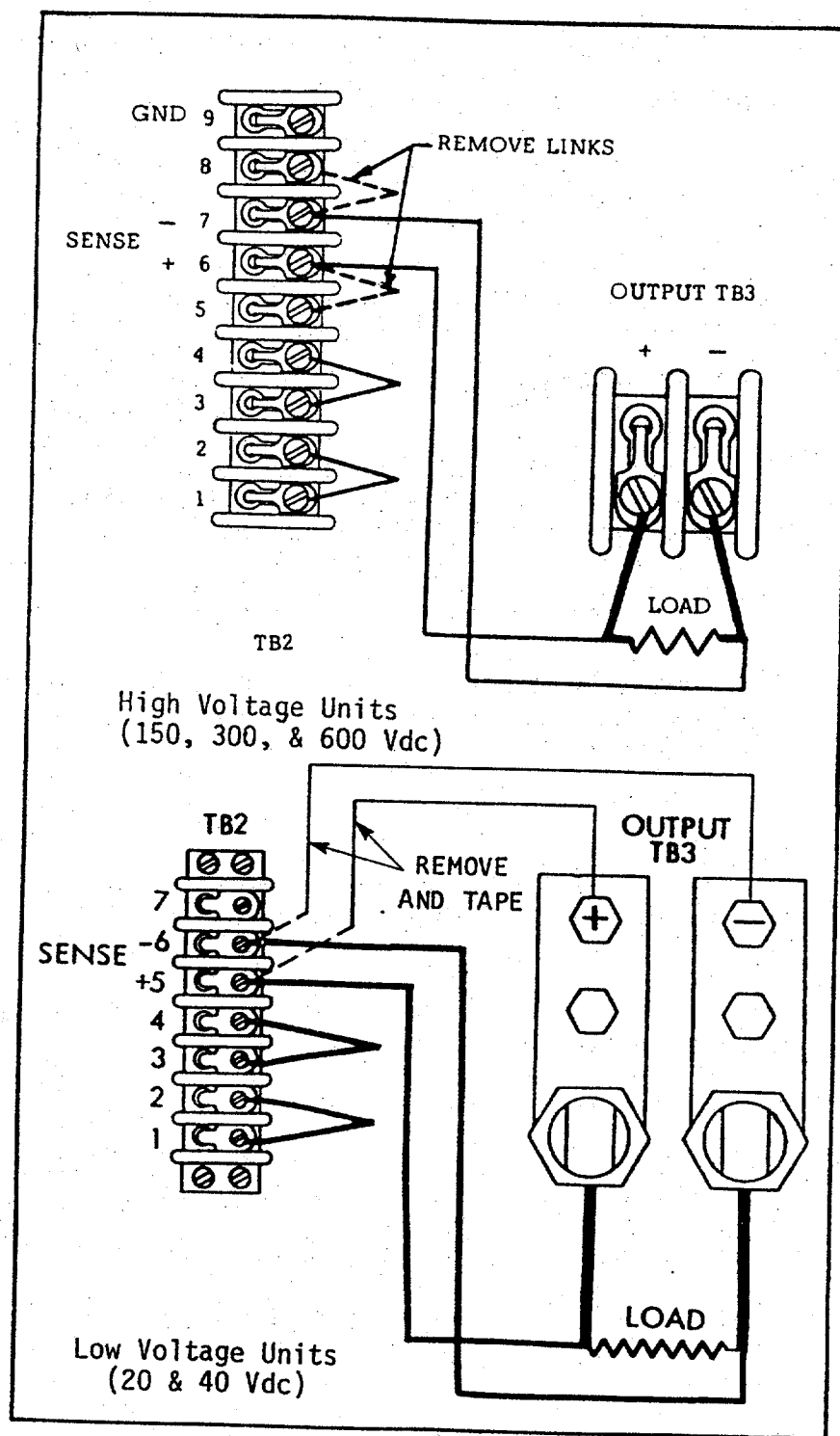


Figure 3-3 Remote Sensing Configuration

volt unit is 80 ohms/volt. For a certain voltage output, therefore, the voltage value must be multiplied by the ohms per volt sensitivity to arrive at the correct value for programming resistance.

For example, for a 25 volt output from a 40 volt full scale unit; $25V \times 80 \text{ ohms} = 2000 \text{ ohms}$.

The resistor used should have a low temperature coefficient ($\pm 30\text{PPM}$) to maintain the units rated temperature characteristics as well as stability. Programming current is about 2 ma. Choose a resistor with a wattage rating at least 2 times that calculated. For a precision method of the calibration of ohms per volt, see para. 3.6.2.

To adapt the unit to external voltage programming, proceed as follows:

- a. Set unit circuit breaker to OFF.
- b. Remove link between terminals 3 and 4 (VOLT PROG) on terminal board TB2 and retain.
- c. Connect programming resistor across terminals 3 and 4. (See Figure 3-4 for diagram of voltage programming connection)
- d. Rotate COARSE and FINE VOLTAGE ADJUST potentiometers fully counterclockwise.

NOTE

The voltage adjust potentiometers are in series with the programming device. Rotation of either of these controls from zero position will affect programmed voltage.

- e. If the unit is being placed on line for the first time or is being returned to the line following a maintenance check, etc., assure that input is connected properly (paragraph 2.5) and that a current limiting value is set on CUR. ADJ. AMPS control.

NOTE

Regulation will drop off if output current is within 10% of set limit.

- f. Set the unit circuit breaker to ON. POWER ON lamp will light.

NOTE

If voltage programming is to be discontinued, remove programming device and REINSERT LINK BETWEEN TERMINALS 3 and 4 of terminal board (TB2).

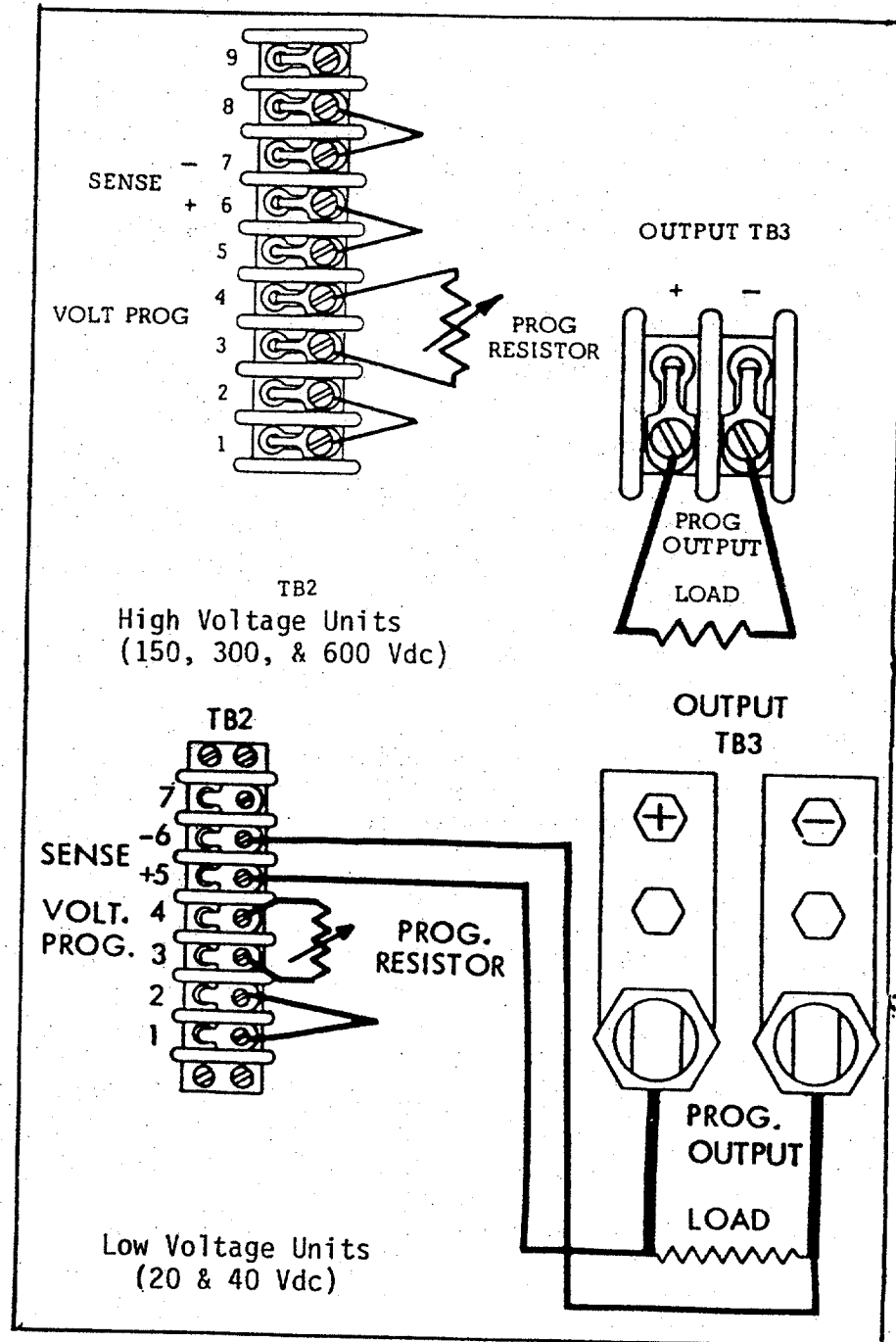


Figure 3-4 Voltage Resistor Programming (With Remote Sensing)

3.6.2 Precision Calibration (Voltage Mode)

If it is desired to precisely calibrate the programming ohms per volt, proceed as follows:

- a. Rotate COARSE and FINE VOLTAGE ADJUST controls fully counter-clockwise.
- b. Remove link between terminals 3 and 4 (VOLT PROG) on terminal board (TB2) and retain.
- c. Connect a precision 3.2K ohm resistor (for low voltage units) or a precision 3.0K ohm resistor (for high voltage units) between terminals 3 and 4.
- d. Connect a precision voltmeter across output terminals. Set the voltmeter for a range at least that of full scale output of the power supply.
- e. Set unit circuit breaker to ON. Allow at least a 30 minute warm up period.
- f. Adjust resistor R39 on component board assembly (located at rear of unit behind left hand panel) for rated full scale output voltage.
- g. Short circuit precision resistor.
- h. Adjust resistor R43 on component board assembly for a $0 \pm .1$ volt output. (Reset voltmeter range appropriately)
- i. Set voltmeter range to at least 125% of full scale voltage output, remove the short circuit, and adjust R39 for rated full scale output voltage $\pm .3\%$.
- j. Disconnect precision voltmeter.

NOTE

Unit is now calibrated to programmed voltage $\pm .3\%$ (plus tolerances of precision resistor and voltmeter, and regulation of the unit). Linearity of programming is $\pm .5\%$.

- k. Remove precision calibrating resistor and insert programming resistor. Refer to paragraph 3.6.1.

3.6.3 Current Mode

The unit may be programmed externally to provide a fixed, predetermined output current. This is accomplished by inserting a resistor in the current mode reference-voltage circuit (See Figure 3-5 for a diagram illustrating the current programming configuration).

The current programming sensitivity varies with model. Table 1-2 lists each value. In order to obtain the proper program resistance for individual requirements, proceed as follows:

- a. Determine ohms per ampere from Table 1-2.

- b. Multiply the ohms per amp sensitivity, found in step a, by the desired programmed current. (e.g.) To obtain 200 amps from the DCR 20-250A, calculate resistor needed as follows:
- a. 0.6 ohms/amp per Table 1-2.
- b. $200\text{A} \times 0.6 = 120 \text{ ohms}$.

NOTE

The resistor used should have a low temperature coefficient ($\pm 30 \text{ PPM}$) to maintain the units rated temperature characteristics as well as stability. Programming current is about 2 mA. Use a 1% resistor with a wattage rating of 1/8W or larger.

To convert the unit to current programming mode, proceed as follows:

- a. Set unit circuit breaker to OFF.
- b. Remove link between terminals 1 and 2 (CUR.PROG.) of terminal board (TB2).
- c. Insert programming resistor across terminals 1 and 2.
- d. Rotate CUR. ADJ. AMPS and COARSE and FINE VOLTAGE ADJUST controls fully counterclockwise.

NOTE

The current program potentiometer is in series with the program device. Rotation of the control from the zero position will affect programming.

- e. If the unit is being used for the first time, or if it is being returned to operation following a maintenance check, etc., assure that a three phase input is properly connected (paragraph 2.8).
- f. If applicable, disconnect load lines; then set unit circuit breaker to ON.
- g. Rotate COARSE VOLTAGE ADJUST control until unit voltmeter indicates 5% above desired dynamic voltage.

NOTE

Current regulation will drop off if dynamic voltage rises to within 5% of voltage setting.

- h. Set unit circuit breaker to OFF, and reconnect load lines.
- i. Set unit circuit breaker to ON. Turn CUR. ADJ. AMPS control to desired regulating value. CURRENT MODE lamp lights indicating current mode operation.

NOTE

If current programming is to be discontinued, remove programming resistor and REINSERT LINK BETWEEN TERMINALS 1 and 2 of terminal board (TB2).

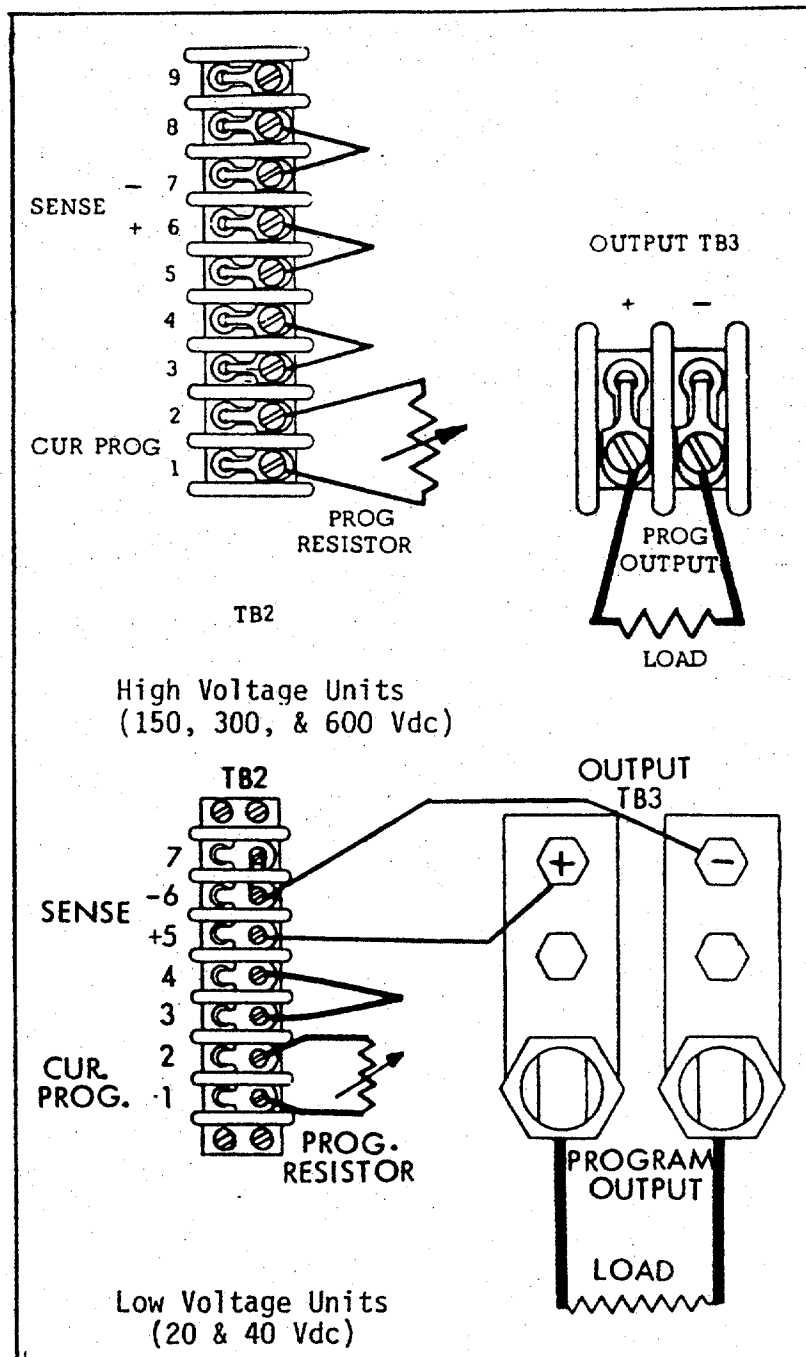


Figure 3-5 Current Resistance Programming

3.7 EXTERNAL SIGNAL PROGRAMMING

3.7.1 Voltage Mode

The unit may be programmed externally to provide a variable output as a function of an input voltage signal. This is done by introducing the external signal into the voltage reference circuit of the voltage mode stage.

In selecting a signal source, the following should be considered:

1. The source must be capable of absorbing about 3 mA. (The Programming Current)
2. A floating (ungrounded) source must be used.
3. To obtain a full scale voltage output range the source must provide a 0 to full scale volt signal per table below.

To convert the unit for external voltage signal programming, follow procedures outlined in paragraph 3.6.1, with one exception. Where step "c" calls for insertion of a resistor across terminals 3 and 4, connect the signal source instead. (See Figure 3-6 for connection). Observe polarity.

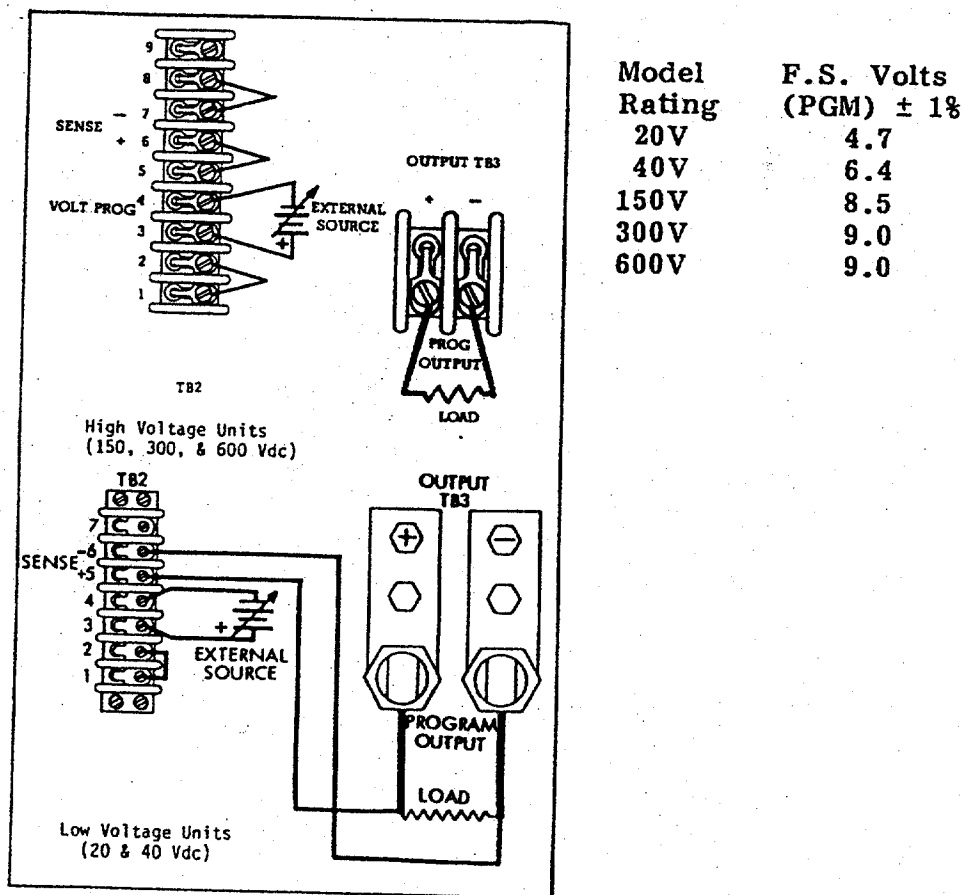


Figure 3-6 Voltage Signal Programming (With Remote Sensing)

3.7.2 Current Mode

A voltage signal may be introduced into the reference circuit of the current mode section to provide a variable current output. This output will be a function of the input signal.

In choosing a signal source, the following should be considered:

1. The source must be capable of absorbing about 2 mA.
2. It must be ungrounded and,
3. for full rated output range, it must provide a 0 to .3V signal ($\pm 10\%$).

To adapt the unit to external signal programming, follow procedures in paragraph 3.6.3, with this exception: instead of inserting a programming resistor across terminals 1 and 2 as stated in step "c", insert the programming source. See Figure 3-7 for connection. Observe polarity.

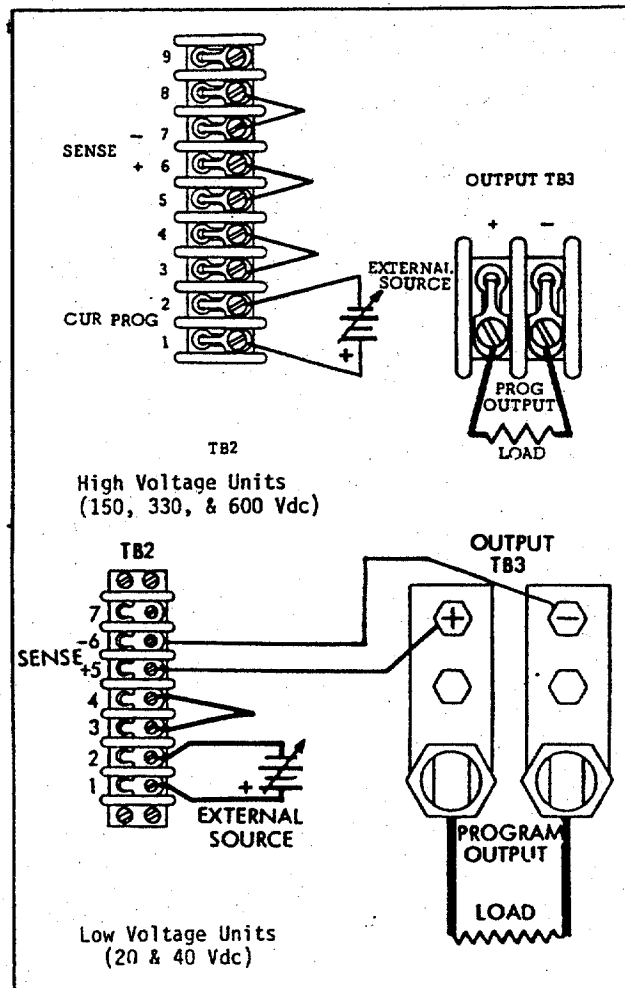


Figure 3-7 Current Signal Programming

3.8 ALTERNATE PROGRAMMING METHODS

There is an alternate programming method for each mode, which eliminates the possibility of altering the programmed output by varying the applicable front panel control.

3.8.1 Voltage Mode by Resistance

To use the alternate programming method, read and follow the procedures outlined in para. 3.6.1, with one exception. Instead of connecting program resistor between terminals 3 and 4 (VOLT PROG) of terminal board (TB2) as stated in step "c", connect the resistor between terminal 3 and terminal 32 (terminal 32 is located on the upper right hand side of the component board immediately adjacent to TB2). Remove harness wire in hole 32 and tape.

3.8.2 Current Mode by Resistance

To adapt unit for current programming using the alternate method, proceed as outlined in para. 3.6.3 with one exception. Replace step "c" with: "Insert programming resistor between terminal 1 and terminal D (located on the component board immediately adjacent to TB2).

3.8.3 Voltage Mode by Voltage Signal

To use alternate programming method, follow procedures outlined in paragraph 3.7.1, with one exception: instead of connecting signal source across terminals 3 and 4 (VOLT.PROG.) connect the source across terminal 3 of TB2 and terminal 32 (located at the upper right hand side of component board assembly immediately adjacent to terminal board TB2). Remove harness wire in hole 32 and tape.

3.8.4 Current Mode by Voltage Signal

To use alternate programming method, follow procedure outlined in paragraph 3.7.2 with one exception. Instead of connecting the signal source across terminals 1 and 2 (CUR.PROG.) of TB2, connect source between terminals 1 and D. (Located on component board assembly immediately adjacent to terminal board TB2.)

3.9 PARALLEL OPERATION

Paralleling of three phase DCRA units is accomplished directly by connecting the individual supplies to the load. Using this method, no current derating due to composite tolerances of wire resistance, components, etc., is required. There are no restrictions on the number of units that may be paralleled. However, paralleling units does result in lower overall regulation.

The following lists the procedures to be followed in directly paralleling two units. The procedure is applicable to any number of units, however. (See Figure 3-8 for connections.)

NOTE

The paralleled units may be adapted for remote sensing as illustrated in Figure 3-8. They may also be adapted for resistance or signal programming. None of these are required for parallel operation, however.

- a. Set unit circuit breakers of both units to OFF.
- b. If applicable, disconnect output lines and sensing leads at both units.
- c. Set both unit circuit breakers to ON. POWER ON indicators light.
- d. Rotate COARSE VOLTAGE ADJUST control at one unit to desired output; repeat procedure for the other unit. Match unit output by using respective FINE VOLTAGE ADJUST controls.
- e. Set CUR. ADJ. AMPS control on each unit to one-half of the total desired limiting current, (e.g.) if desired to limit load current at 15A, set each control to 7.5A, etc.
- f. Connect output cables from each unit to load. If desired, connect the remote sensing leads of each unit to load.
- g. Set both unit circuit breakers to ON. POWER ON indicators light. The unit which is supplying the highest voltage (it is impossible to identically match the output voltages) will supply load. If the load requirements exceed the setting on CUR. ADJ. AMPS control, this unit will automatically crossover to current mode operation and its output voltage will drop. The second unit will assume that portion of the load rejected by the first. Any further increases in load will be supplied by the second unit up to its current limiting setting. Regulation, therefore, will be the sum of the regulation of the two units plus the difference in the voltage settings. Set each current limit as needed to limit current to 100% of rated.

3.10 SERIES OPERATION

Series operation allows the user to connect as many as five 20 or 40 volt DCR units in series. Only two of the 150 and 300 volt units may be connected in this manner, while the 600 volt unit may not be connected in a series configuration. No derating is inherent in series operation, and regulation is the sum of the regulation of all units.

The following outlines procedures for connecting two units in series. The same procedure may be used for series connecting up to five units. (See Figure 3-9 for a schematic of connections.)

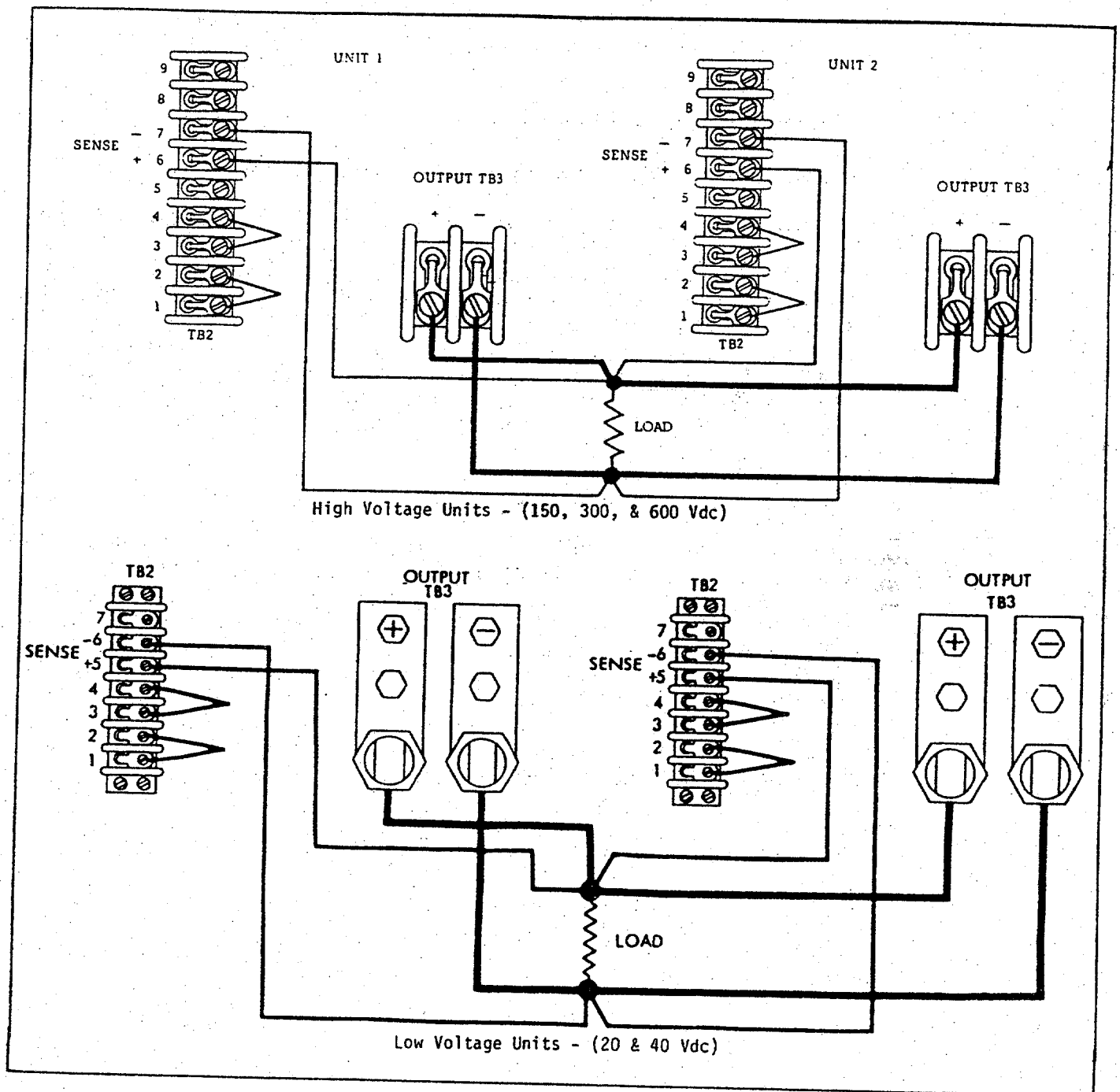


Figure 3-8 Parallel Operation (With Remote Sensing)

NOTE

Series units may be connected for remote sensing as indicated in Figure 3-9 or, they may be adapted to resistance or signal programming. None of these, however, is required for series operation.

- a. Set desired voltage output of each unit at no load using COARSE and FINE VOLTAGE ADJUST. Select current limiting value.
- b. Set unit circuit breaker on both units to OFF.
- c. Connect an output lead from the positive output terminal of one unit (for the sake of clarity, call this unit 1) to the negative output terminal of unit 2.
- d. Connect an output lead from the unit 1 negative terminal to the load; connect the other output lead from the unit 2 positive terminal to the load.

CAUTION

In series operation, rectifiers must be connected across each set of output terminals as shown in Figure 3-9. Failure to do so may result in damage to output capacitors. See para. 3-11 for information on rectifier selection.

- e. If remote sensing is desired, proceed as follows: See Figure 3-9.
 1. Connect a sensing lead from the (-SENSE) terminal on unit 1 terminal board TB2 to the load termination of unit 1 negative output lead. If applicable, remove local sensing lead from (-SENSE) terminal on unit 1. Tape loose end and fold back.
 2. Connect a sensing lead from the (+SENSE) terminal on unit 1 terminal board TB2 to the negative output terminal of the unit 2 terminal board TB3. If applicable, remove local sensing lead at (+SENSE) terminal of unit 1 terminal board TB2, tape loose end and fold back. Do not remove local sensing lead at (-SENSE) terminal of unit 2 terminal board TB2. If necessary, reconnect.
 3. Run a sensing lead from (+SENSE) terminal of unit 2 terminal board TB2 to the load termination of the unit 2 positive output cable. If applicable, remove local sensing lead at (+SENSE) terminal of unit 2, tape loose end and fold back.
- f. Set unit circuit breakers to ON. POWER ON indicators lights. Each unit operates as a separate entity with the output of each independently adjustable. Each may be turned on or off separately. (The rectifiers protect the OFF unit).

3.11 SERIES OPERATION RECTIFIER

When operating units in series, connect rectifiers across the individual unit outputs. Assure the diodes have current and voltage capability at least equal to its associated supply. Adequate heatsinking should be used.

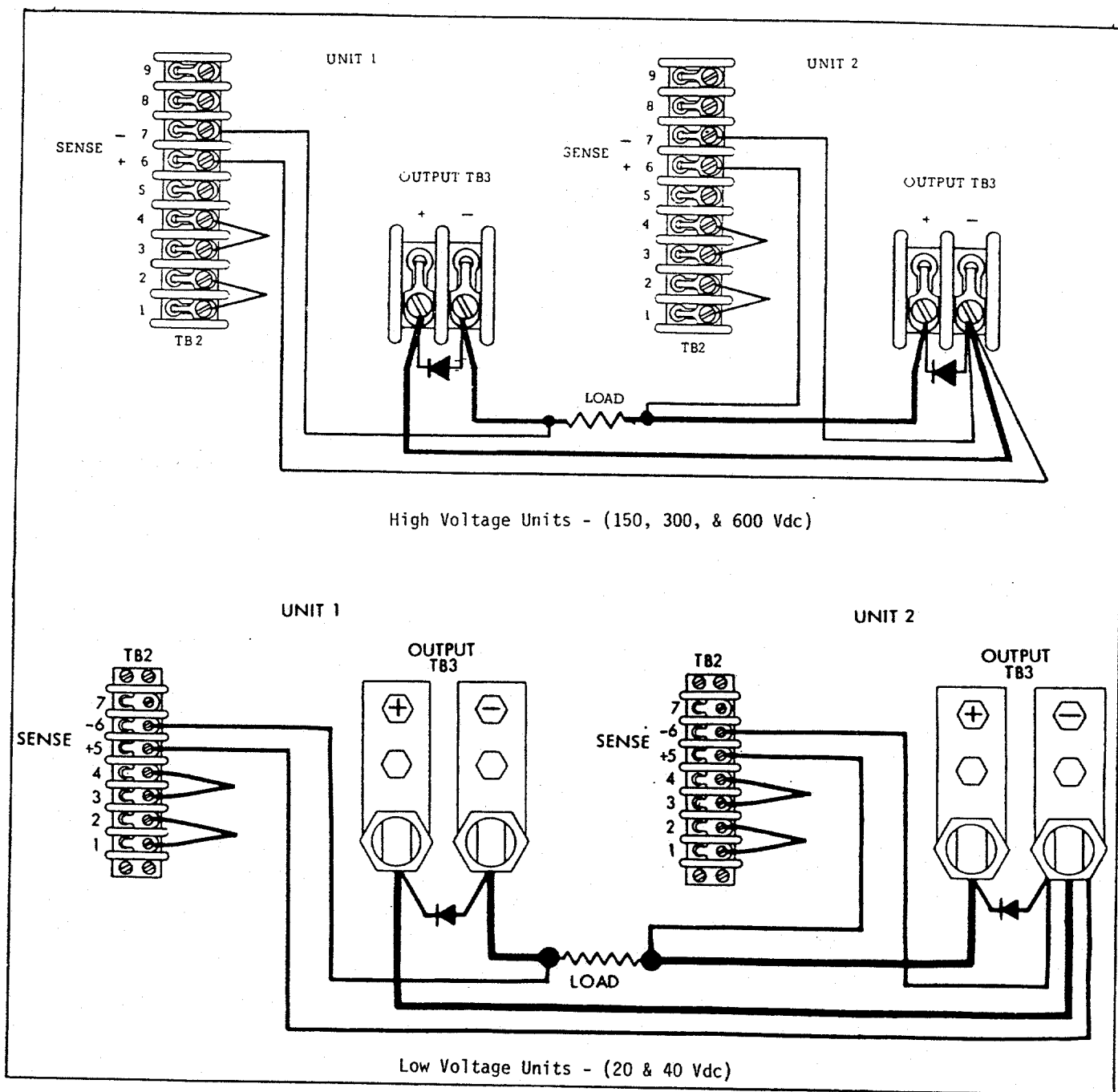


Figure 3-9 Series Operation (With Remote Sensing)

SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION

This section is designed to provide general knowledge of the internal functioning of the unit. This knowledge is essential for troubleshooting in the field as well as proper operation.

To aid understanding of basic unit operation, a brief overview of the material to be covered, referencing the block diagram in Figure 4-1 is given. This will be followed by a more detailed explanation of the various sections and subsections shown on the block diagram.

4.2 FUNCTIONAL DESCRIPTION

For an understanding of unit operation, it is important to understand what is meant by phase control. Consider Figure 4-2, which, for the sake of simplicity, represents only a single phase input voltage to a resistive load. If, by some means, conduction of this voltage can be delayed, then the average voltage output of the positive half cycle will be reduced. Control of the delay, then, results in control of the average voltage. This is phase control, and the device used in the DCRA series to provide this delay is the Silicon Controlled Rectifier (SCR). The delay is expressed in degrees and is known as the firing angle. Figure 4-2 shows firing angles of 60° (shaded area plus cross hatched area) and 120° (cross hatched area only).

For the remainder of this discussion, please refer to the block diagram, Figure 4-1. In the main power circuit, the three phase input voltage is fed into the main transformer and SCR control. The output of the transformer is rectified, and then L-C filtered to deliver dc at the output.

In addition to the main transformer, there is an auxiliary transformer, delta connected across the input, which provides power for both a control circuit voltage regulator and the SCR firing network. This network uses transformer output to correctly sequence the SCR firings with the appropriate phase. The control circuit voltage regulator provides a highly stable, precise voltage and current mode sections. The voltage mode section monitors the output voltage, and when variations occur in the output, it signals the SCR firing network to alter the SCR firing angle. This results in either a compensating increase or decrease in the main transformer output, which is reflected instantaneously in the unit output.

The current mode section performs basically the same function as the voltage mode only it is, of course, monitoring current output while the unit is current regulating.

4.3 DETAILED DESCRIPTION

The following paragraphs contain detailed descriptions of the various sections of the supplies. For location of the circuit symbol components in parentheses throughout the discussions see the schematic diagram located in Section 6.

4.3.1 Control Circuit Regulator

The control circuit voltage regulator provides a stable, regulated 20 Vdc source. It consists of two differential amplifiers (Q5, Q6 and Q3, Q4), a zener diode (CR20), a passing stage (Q2) and a constant current generator (CR18, CR19, R14, R15, and Q1). Output appears across capacitor (C10). This section is supplied by transformer (T4) through a center tapped, full wave rectifier circuit (CR16, CR17).

The output voltage of the supply is sensed across potentiometer (R20) where a portion of the drop is compared with a voltage reference supplied by diode (CR20). The resulting error signals are amplified and fed to the base of pass transistor (Q2). Q2 acts as a variable impedance, increasing or decreasing the voltage drop across the stage as a function of the output voltage.

For example, assume that a rise in voltage is sensed across R20. The base of Q6 will become more positive, and more current will flow through the transistor. This results in a decrease in the current available for the base of Q4. Q4 conducts less, and transistor Q3 conducts more. Since the current from the generator (Q1, CR18, CR19, R14, R15) is constant, an increase in current through Q3 results in a decrease in current to the base of pass transistor Q2. This effectively increases the impedance and the voltage drop across the stage thereby holding the 20 volt potential constant.

4.3.2 Voltage Mode Section

The voltage mode section monitors the output voltage, detects variations and sends an error signal to the SCR firing network. It consists of a differential amplifier (Q12, Q13), constant current generators (Q9, Q11, Q14, and their associated circuitry) and emitter follower (Q7).

The circuit functions as follows: the output voltage is divided across resistors (R51, R52), a beta network, with a sample of the voltage appearing across the base-emitter of transistor (Q13). This voltage is compared with a reference voltage developed across resistors (R41, R42, R43). The resulting voltage error will cause an increase in current in either Q12 or Q13. An increase in current in Q12 will occur if the sensed output voltage is decreasing and in Q13 if the output voltage is increasing. For example, if the output voltage starts to rise, the base of Q13 will become more positive resulting in an increase of current through Q13. Since current generator (Q14) will only pull a constant current and since the current through Q13 has increased, the current through Q12 and, therefore, resistor (R46) will decrease. The voltage drop across this resistor will decrease, and this drop will be reflected in the output of emitter follower (Q7). Q7 output then goes to the SCR firing network where the voltage level determines firing angle delay.

Constant current generator (Q9) supplies an operating current to transistor (Q12), allowing resistor (R46) to have a large value. This large value results in greater gain.

The voltage reference for the differential amplifier, derived from both the constant voltage of the internal voltage regulator (refer to paragraph 5.3.1) and a constant current generated by (Q11), is developed across resistors (R41, R42 and R43).

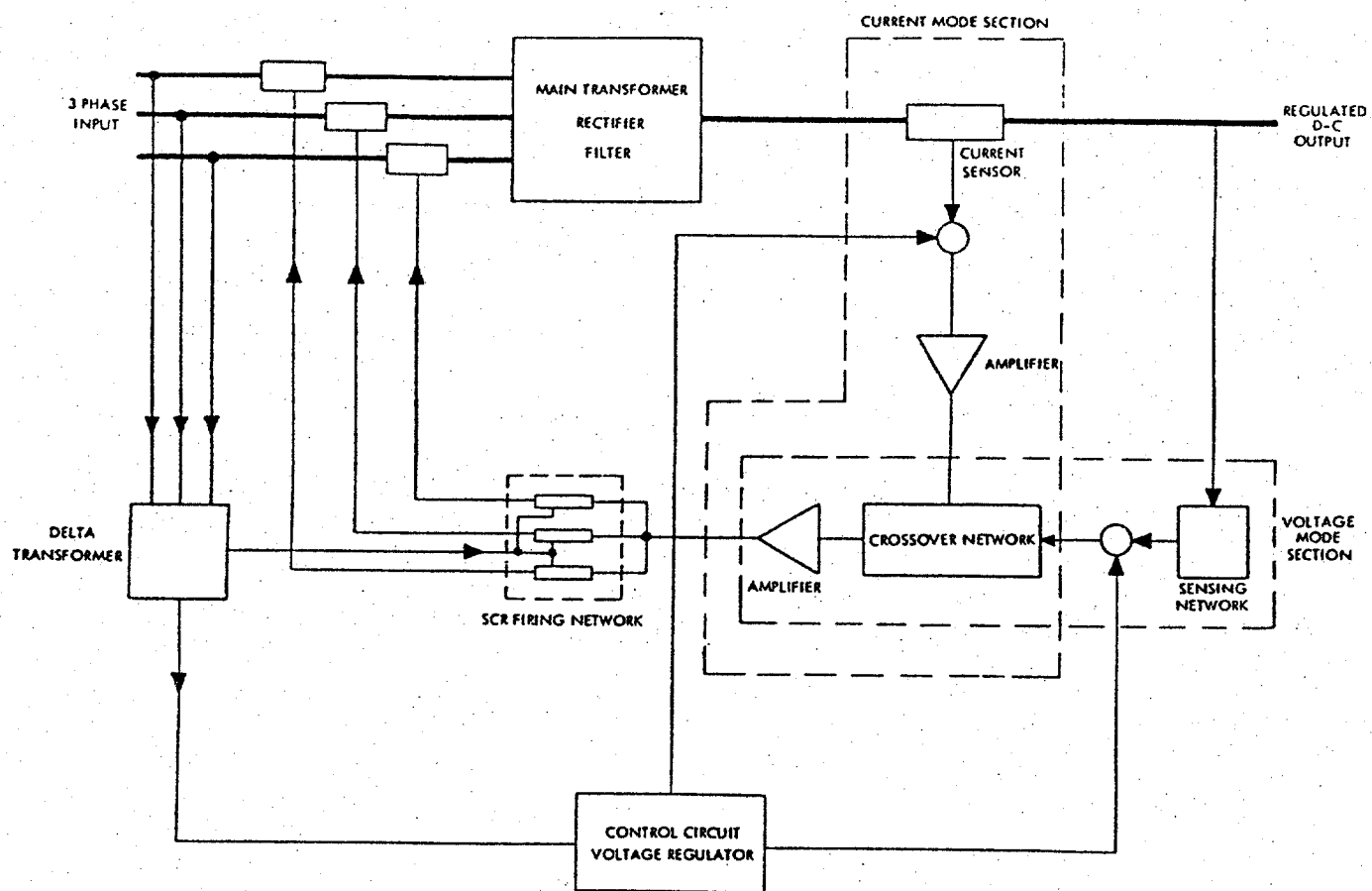


Figure 4-1 Unit Block Diagram

R41 and R42 are the control panel potentiometers which, by varying the amplifier reference voltage, adjust the output voltage. No variations in differential-amplifier current due to the variable reference voltage are observed because transistor (Q14) pulls a constant current through the amplifier.

4.3.3 Current-Mode Section

The current mode section consists primarily of current sensing resistor (R13), variable resistors (R23, R24, R25), amplifier (Q8, Q10) and diode (CR23). These function in conjunction with constant current generator (Q14) to effect crossover and limit the current output to the selected value.

The circuit works as follows: when the output current rises above the selected value (R24 is the current output adjust), the drop occurring across resistor (R13) is sufficient to reduce the conduction level of Q8. The collector output of Q8 is then fed to the base of Q10, which increases the current flow through this transistor. Its output is fed to both the emitter of Q14 and the base of Q15. Sufficient drive on the base of Q15 will cause enough conduction to light the current mode indicator (DS2). The current into the emitter of Q14, however, provides the limiting feature. This current may be considered as part of the constant current of Q14. Therefore, the current into the collector of Q14 must decrease to maintain the constant level. This results in a drop in the voltage across resistor (R46). This drop is reflected in the output of emitter follower (Q7) and results in an increased delay of SCR firing. This reduces the output current.

Reference for amplifier (Q8) is provided by the voltage regulator section (refer to paragraph 4.3.1) and resistors (R23, R24, R25, and R26).

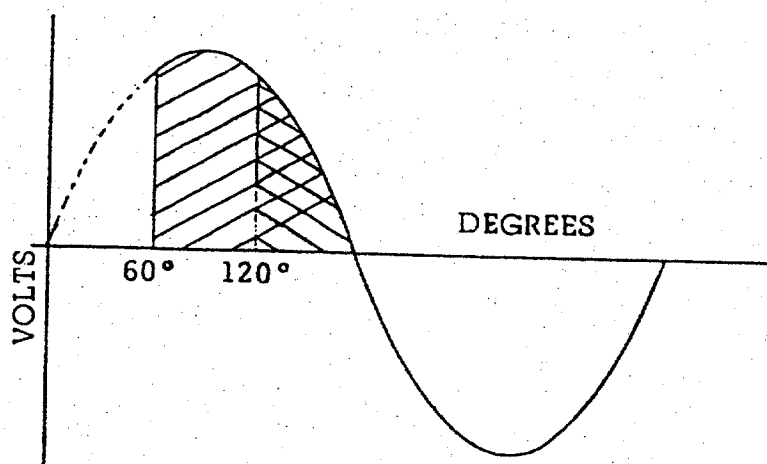


Figure 4-2 Single-Phase Input Wave

4.3.4 SCR Firing Network

Three separate but identical firing circuits, one for each phase, make up the firing network. Power for the network is supplied by transformer (T4). This transformer has a delta connected primary, and three single phase and two wye-connected secondaries. The single phase secondaries are connected to the firing circuits, one per phase. This insures the correct phase relationship between a firing circuit and the voltage across its SCR. A typical firing circuit consists of resistors (R59), zener diode (CR28), transistors (Q16), capacitor (C21), unijunction transistor (Q17), and pulse transformer (T6). The other two circuits are located directly below on the schematic diagram.

Basically, the circuit works as follows: input from the secondary of transformer (T4) is clipped by zener (CR28), and fed across transistor (Q16) and unijunction transistor (Q17). Q16 is a constant current generator whose output is determined by the voltage drop across (R22) in the emitter follower (Q7) circuit. (The drop across R22 is a function of the main output). Q16 then, controls the charge rate of capacitor (C21). This rate is important since the charge on C21 determines the firing point of unijunction transistor (Q17). As the charge builds up, Q17's breakover voltage is reached and C21 discharges through Q17 to the pulse transformer (T6). The pulse is fed to the gate of silicon controlled rectifier (CR1), and the SCR fires.

For example, assume a rise in output voltage. The drop across R22 is lowered and the current through Q16 is diminished. The charging rate of C1 is slowed, and discharge through Q17 is delayed. This results in a retardation in the SCR firing angle and a decrease in the average output of the bridge (CR11, CR12).

4.3.5 Phase Failure Shutdown

If a phase of input line fails, a lamp (DS4) will light and unit output will go to zero. The failure sensing and shutdown circuits consists of two wye connected secondaries of transformer (T4), diodes (CR31 through CR36), relays (K1, K2), lamp (DS4), resistor (R71), and constant current generator (Q14).

The circuit functions as follows: removal of an input phase will cause an unbalance in the phase voltages being compared across relays K1 and K2. This unbalance causes a current to flow in either relay, and the affected relay trips. Closing of either relay's contacts makes the circuit between a power source (CR34, CR35, CR36) and the indicating light. The current flowing through the light is also introduced into the emitter circuit of Q14, and causes a large drop in the current flowing through R46. The output then drops to zero (refer to paragraph 4.3.2 and 4.3.4 for an explanation of how a drop in the voltage across R46 decreases the main output voltage). Resistor (R71) across lamp DS4 insures shut down in the event of a lamp burn out.

4.3.6 Thermal Overload Shutdown

If the unit overheats, one of three (or four) thermostats (S1, S2, S3 or S4) energizes lamp (DS1) to give an indication of failure and also to introduce a large current into the emitter of Q14. The output voltage then drops to zero due to the decrease in drop across resistor (R46). (Refer to paragraph 4.3.2 and 4.3.4 for explanation). Resistor (R55) insures operation of the fan failure circuit in the event of lamp (DS1) failure.

4.3.7 Radio Frequency Suppression

Choke coils (L1, L2, and L3) and capacitors (C37 through C40) suppress radio frequency interference from semiconductor commutation.

SECTION 5

MAINTENANCE

5.1 GENERAL

This section is designed to provide sufficient data for the maintenance and repair of the unit. In addition, calibration procedures are included. The material in this section is presented in this order: a general troubleshooting chart outlines common symptoms and possible causes for them. Where these common troubles require deeper analysis, a reference is made to a test procedure. The results of this dynamic test procedure will provide an evaluation of a particular section's performance. If a section's performance is not as specified, then a further reference is made to a local troubleshooting chart, where a listing of possible component failures is provided. Calibration procedures are described next, followed by performance testing.

5.2 TESTING

Table 5-1 outlines the procedures for testing major sections of the unit. It is recommended that the order be followed as presented.

NOTE

If components such as unijunction transistors (Q17, Q19, and Q21) or components from the differential amplifiers are replaced, recalibration may be required. Refer to para. 5.3.

5.2.1 Control Circuit Voltage Regulator

To test the voltage regulator section proceed as follows:

- a. Remove unijunction transistors (Q17, Q19, and Q21). This effectively disables the power circuit. Mark each transistor so that it may be reinserted in the same socket.
- b. Connect a 0-50 Vdc voltmeter across capacitor (C10).
- c. Apply nominal three phase input to terminal board TB1 and close unit circuit breaker. Power is applied to voltage regulator through transformer. Voltmeter should indicate 20.0 ± 0.1 volts. If it does not, adjust using potentiometer R20. "Glyptal" R20 after adjustment.
- d. Vary input voltage through entire range (refer to Tables 1-1 and 1-2, respectively, for unit and auxiliary supply input specifications). Regulation should be 2 mV or better.

Table 5-1 General Troubleshooting

<u>SYMPTOM</u>	<u>TROUBLE</u>	<u>SYMPTOM</u>	<u>TROUBLE</u>
No output	a. Check input. b. Unit circuit breaker tripped. (Check power circuit, diode CR23 and transistor Q15 if breaker continues to trip after respective resetting). c. Thermal overload circuit operative. THERMAL OVERLOAD indicator glows. Check for defective thermostat. Check each cooling fan input voltage with 120 Vac voltmeter. Voltage should be 115 Vac nominal. d. Failure in control circuit voltage regulator. Refer to para. 5.2.1. e. Defect in voltage-mode section. Test section per para. 5.2.3. f. Current-mode section failure. Refer to para. 5.2.3. g. Input phase failed.	High voltage output	a. Failure in control circuit regulator. Refer to para. 5.2.1. b. Failure in voltage mode section. Refer to para. 5.2.2.
		Low output	a. Check input. Table 1-2 for input specifications. b. Faulty control circuit voltage regulator. c. Failure in voltage mode section. Refer to para. 5.2.2. d. Defective current mode section. Test per para. 5.2.3. e. Silicon controlled rectifier open, or defective firing circuit. See Figure 5.1 for oscilloscope patterns of both normal ripple at no load and ripple with a faulty firing circuit.
High output current (no limiting)	First test control circuit regulator and voltage mode section (para. 5.2.1) and 5.2.2, respectively); then check current mode section per para 5.2.3.	PHASE FAILURE light glows	a. Open CR31, CR32 or CR33. b. Shorted CR16 and CR17.

- e. If regulator does not perform as specified, refer to Table 5-2 for troubleshooting. Terminate procedure by setting unit circuit breaker to OFF and reinserting transistors Q17, Q19, and Q21 in their respective sockets.

Table 5-2 Voltage Regulator Troubleshooting

<u>SYMPTOM</u>	<u>TROUBLE</u>
Regulator Output about 12V	a. Transistors Q1, Q2, A4 or Q5 open. b. Transistor Q3 or Q6 shorted. c. Potentiometer R20 defective (negative side open). d. Diode CR20 shorted. e. Check input to regulator by connecting an oscilloscope (0.5V/cm, 1 ms/cm) and a 0-50 volt dc voltmeter across capacitor C9. Ripple should be about 1.2V and voltage should be about 42V.
Regulator Output about 30V	a. Defective R20 (wiper open or positive side open). b. Transistor Q3 open. c. Diode CR20 open. d. Shorted transistor W2, Q4, or Q5. e. Diode CR18 or CR19 open.

5.2.2 Voltage Mode Section

To test the voltage mode section, proceed as follows:

- a. Remove unijunction transistors (Q17, Q19, and Q21). This effectively disables the power circuit. To insure that each transistor will be returned to the socket from which it was removed, mark each for identification. Remove transistor (Q10).

NOTE

A failed power circuit component may result in continued output. Check before proceeding.

- b. Short the output terminals. The 20 volt regulator output will then appear across the beta network (R51 and R52).
- c. Connect an oscilloscope across capacitor (C21). Set vertical sweep to 5V/cm; horizontal to 5 ms/Cm, ac coupling.
- d. Set COARSE and FINE VOLTAGE controls fully counterclockwise and CUR. ADJ. AMPS control to about 20%.

- e. Apply nominal input and close unit circuit breaker. The control circuit voltage regulator will function on power supplied by transformer (T4).
- f. Observe oscilloscope. A single horizontal line should be displayed. If a square wave pattern develops, it is indicative of high unit output voltage. Refer to Table 5-3.
- g. Rotate FINE VOLTAGE ADJUST control a few degrees clockwise and observe oscilloscope. Repeat procedure until a sawtooth pattern appears on oscilloscope. The rise time of the sawtooth should be controllable by slight rotation of FINE VOLTAGE ADJUST.

NOTE

Lag time between rotation of control and unit response (as indicated on oscilloscope) is 5 to 10 seconds. A change of oscilloscope patterns from straight line to square wave without a sawtooth is an indication that the increments of control rotation were too great. Repeat step "g" using a smaller degree of turning.

- h. The above procedures checked the voltage mode section and a portion of the firing circuit (transistor Q16, diode CR28 and capacitor C21). Repeat entire procedure with the oscilloscope across capacitor C22 and then across capacitor C23. This will check a portion (Q18, CR29, C22, and Q20, CR30, C23) of each of the other two firing circuits.

NOTE

Inability to achieve a sawtooth across any of the capacitors is an indication of a voltage mode section failure (refer to Table 5-3); lack of a sawtooth across a single capacitor is indicative of a failure in the firing circuit.

- i. Terminate test by opening unit circuit breaker, removing short from output terminals, and replacing transistors (Q17, Q19, and Q21) in their respective sockets. Reinsert transistor (Q10).

5.2.3 Current Mode Section

If tests of both the voltage regulator and voltage mode sections show them to be operating properly, proceed as follows to test current mode operation:

- a. Turn FINE and COARSE VOLTAGE ADJUST. and CUR. ADJ. AMPS controls fully counterclockwise.
- b. Connect a 0-1 volt dc voltmeter across the unit output terminals.

Table 5-3 Voltage Mode Section Troubleshooting

<u>SYMPTOM</u>	<u>TROUBLE</u>
No Unit Output. Straight line display on oscilloscope (refer to para. 5.2.2)	a. Transistor Q13, Q14 or Q9 shorted. b. Potentiometer R39 open. c. Transistor Q11 or Q12 open. d. Transistor Q13 open. Initial symptom: output voltmeter pointer pegs, then output drops to zero. e. Transistor Q12 shorted. See "d" for initial symptom.
High Unit Output. Square Wave display on oscilloscope (refer to para. 5.2.2)	a. Potentiometer R41, R42 or R43 open. b. Transistor Q11 shorted. c. Transistor Q9 open. d. Potentiometer R43 wiper open.
Unit Output goes to Maximum; COARSE VOLTAGE ADJUST has no effect	Potentiometer R41 wiper open.
Low Output Voltage	Diode CR24 open.

- c. Make certain properly sequenced three phase input is available and then set unit circuit breaker to ON.
- d. Rotate FINE VOLTAGE ADJUST control until 0.1 to 0.3 volts is indicated on test voltmeter.
- e. Open circuit breaker and disconnect test voltmeter. Connect about a two foot length of No. 8 wire across output terminals.
- f. Close unit circuit breaker. CURRENT MODE indicator will light.
- g. In small steps, rotate CUR. ADJ. AMPS to 20% of full scale while observing ammeter. Ammeter should read output equal to that set on control.
- h. If unit does not function as specified above, refer to Table 5-4.
- i. Terminate test by setting unit circuit breaker to OFF and remove terminal shorting wire.

5.3 CALIBRATION

The following paragraphs list the steps to be followed for complete unit calibration.

5.3.1 Control Circuit Voltage Regulator

Procedures to calibrate the voltage regulator are identical to those listed under paragraph 5.2.1.

Table 5-4 Current Mode Section Troubleshooting

<u>SYMPTOM</u>	<u>TROUBLE</u>
No Output: CURRENT MODE Indicator glows (refer to para. 5.2.3).	a. Diode CR22 shorted. b. Potentiometer R25 defective, check wiper. c. Diode CR23 shorted.
Over-current; CURRENT MODE Indicator glows (refer to para. 5.2.3)	a. Diode CR22 open. b. Potentiometer R24 open.
Over-current; no indication from CURRENT MODE light.	a. Transistor Q8 shorted. b. Transistor Q10 open.
No Current Output, no indication from CURRENT MODE light.	a. Transistor Q8 open. b. Transistor Q10 shorted.
Ammeter indicates maximum output; CURRENT MODE indicator glows; CUR. ADJ. AMPS has no effect.	Defective wiper on potentiometer R24.
Current lower than that set on CUR. ADJ. AMPS control (refer to para. 5.2.3); CURRENT MODE light glows.	Transistor Q15 shorted.
Unit current limiting; no light indication.	a. Burned out lamp. b. Open transistor Q15.

5.3.2 Current Mode Lamp

- Determine that current limiting (See para. 5.3.4) is working properly.
- Set unit circuit breaker to OFF. Short the load terminals.
- Set CUR. ADJ. AMPS control to approximately 25% of rated current.
- Connect a DVM across R56 to ground.
- Set the circuit breaker to ON. DVM should read 8.6 to 9.0 volts. If not, adjust control R57 on the PCB. Current mode light should be on.

5.3.3 Output Voltage

With unit connected to a properly sequenced three phase input, proceed as follows to calibrate unit output voltage.

- Close unit circuit breaker.

- b. Rotate COARSE VOLTAGE ADJUST to obtain a 50% of full rated voltage noload output.
- c. Connect an oscilloscope (.1% of F.S.V/cm, 10 ms/cm ac coupled) across output terminals.
- d. Apply full load and observe oscilloscope pattern. Position horizontal axis so that a comparison between the peaks may be made. Peaks should be adjusted so that all are within a .01% to .015% horizontal band. Use potentiometers R60, R63 and R66.
- e. Disconnect oscilloscope and load.
- f. Rotate COARSE VOLTAGE ADJUST control fully clockwise. Unit output meter should indicate full scale rated voltage. If it does not, adjust potentiometer R39 until output voltage is full scale.
- g. Turn COARSE and FINE VOLTAGE ADJUST controls fully counterclockwise.
- h. Connect a digital voltmeter across output terminals. Test voltmeter should indicate $0 \pm .07\%$. If it does not, adjust potentiometer R43 to bring output to specified value.
- i. Disconnect test voltmeter and turn COARSE VOLTAGE ADJUST control fully clockwise. If unit voltmeter does not indicate rated full scale voltage; readjust potentiometer R39. Repeat steps "h" and "i" until all values are as specified.
- j. Set unit circuit breaker to OFF.

5.3.4 Current Limiting

To perform current limiting calibration, proceed as follows:

- a. Obtain a commercial 50 or 100 mV shunt (100 mV preferred) having a rating 1.5 times the output current of the supply. For example, the 20-1000A, 1000 Amp unit will require a 1500 Amp shunt, the 40-250A, 250A Amp unit will require a 375 Amp shunt, etc.
- b. Connect the shunt across the output of the power supply and connect an appropriate DVM across it.
- c. Set COARSE VOLTAGE ADJUST control and CUR. ADJ. AMPS controls fully counterclockwise.
- d. Set FINE VOLTAGE ADJUST control fully clockwise.
- e. Set unit circuit breaker to ON.
- f. Rotate CUR. ADJ. AMPS control fully clockwise. Test indicator (across shunt) should indicate a full scale current equal to 1.3 times the nameplate rated current. See output ratings in Table 1-2. If it does not, adjust using potentiometer R25.

- g. Rotate CUR. ADJ. AMPS control fully counterclockwise. Test indicator should indicate 0 to 2% of full scale rated current to be within tolerance. If it does not, adjust using potentiometer R23. Repeat steps "f" and "g" until all values are as specified.
- h. Set unit circuit breaker to OFF. Remove shunt and test indicator from output terminals.

5.3.5 Gain Adjust

To calibrate the gain, proceed as follows:

- a. Rotate COARSE VOLTAGE ADJUST and CUR. ADJ. AMPS completely clockwise. Adjust potentiometer R60, R63 and R66 almost fully clockwise.

NOTE

Setting potentiometers (R60, R63 and R66) fully clockwise will cause the output to collapse. Rotate slightly counterclockwise if this occurs.

- b. Reduce input voltage to low end of input specifications. Refer to Table 1-2.
- c. Balance potentiometers R60, R63 and R66 per paragraph 5.3.3, steps a - d.
- d. Check no-load to full load regulation. Regulation should be between .15% and .25% of rated full scale voltage.
- e. Readjust R60, R63 and R66 to obtain a load regulation between .15% and .25% of rated full scale voltage. Use R60 as the gain adjust and R63 and R66 as the balancing potentiometers. Final resistance readings of R60, R63 and R66 must be between 700 and 1500 ohms.
- f. Rebalance ripple voltage per paragraph 5.3.3, steps a - d. "Glyptal" resistors R60, R63 and R66.

5.4 PERFORMANCE TESTING

The following paragraphs outline checks that may be performed on unit output following calibration.

5.4.1 Regulation and Ripple

Proceed as follows to test line regulation and output ripple following a unit calibration.

- a. Apply three-phase low-line voltage to the input terminals. Refer to Table 1-2 for input line specifications.

- b. Connect an oscilloscope across output terminals.
- c. Turn COARSE VOLTAGE ADJUST control fully clockwise; set CUR ADJ. AMPS control to right hand stop.
- d. Close unit circuit breaker.
- e. Set unit output to full rated voltage.
- f. While slowly increasing input voltage, apply load in small increments until input voltage is at high line and current output is 10% above rated nominal output. (e.g., 1000 Amps should read 100 Amps, 250 Amps should read 275 Amps, etc.) regulation should be .1% and ripple less than .3%.
- g. Set unit circuit breaker to OFF. Disconnect oscilloscope.

5.4.2 Transient Response

Test transient response as follows:

- a. Rotate CUR. ADJ. AMPS control fully clockwise.
- b. Set unit circuit breaker to ON.
- c. Connect a dc coupled oscilloscope across output terminals.
- d. Set unit output at full rated label voltage.
- e. Apply half load then apply full load. Then go from full load to half load. Maximum output deviation should be per Table 1-2 value, and return to steady state (full scale voltage $\pm 1\%$) should occur in 40 ms.
- f. Set unit circuit breaker to OFF and disconnect oscilloscope.

5.4.3 Current Regulation

To check unit current regulation, proceed as follows:

- a. Set COARSE VOLTAGE ADJUST to full rated output.
- b. Turn CUR. ADJ. AMPS fully counterclockwise (0 amps).
- c. Connect a commercial shunt (see para. 5.3.4) and DVM readout in series with the load.
- d. Set unit circuit breaker to ON and adjust CUR ADJ pot for 100% current. Note DVM reading.
- e. Short circuit the load and again note the DVM reading across the shunt resistor. The reading should not change more than .2% of rated current.

- f. Set unit circuit breaker to OFF and disconnect shunt and readout device.

NOTE

"Glyptal potentiometers R25, R39, R43, R20, R23 and R57."

5.5 THERMAL OVERLOAD

With a full rated voltage, no load output, short a set of thermostat terminals. Output should go to zero and THERMAL OVERLOAD indicator should light. Repeat procedure for each of the other thermostats.

5.6 PHASE FAILURE

With a full rated voltage, no load output, disconnect an input line. Output should drop to zero and PHASE FAILURE indicator should light. Reconnect input line and repeat test for each of the other two lines.

SECTION 6

DRAWINGS AND PARTS LISTS

6.1 GENERAL

This section consists of schematic diagrams, PCB parts location drawings, and replaceable parts lists. The parts lists are keyed to the applicable schematic diagrams.

6.2 TABLE HEADINGS DEFINED

6.2.1 Circuit Symbol

This is an alpha-numeric identification of the component as called out on the unit drawings.

6.2.2 Sorensen Part Number

This number should be used when ordering parts directly from:

SORENSEN
Sales & Technical Support
9250 Brown Deer Road
San Diego, CA 92121-2294
1-800-525-2024
Tel: (858) 450-0085
Fax: (858) 458-0267
Email: sales@sorensen.com
www.sorensen.com

Table 6-1
Replaceable Parts List
DCR-A Main Assembly

Circuit Symbol	DCR-A Model										Description	Sorensen Part No.
	20-250	20-500	20-1000	40-125	40-250	40-500	150-35	150-70	300-18	300-35		
B1	x			x		x	x	x	x	x	Fan, Muffin	91-1000-2
B2	x			x	x		x		x	x	Fan, Muffin	91-1000-2
B3	x			x	x	x	x	x	x	x	Fan, Muffin	91-1000-2
B4				x			x		x	x	Fan, Muffin	91-1000-2
B1		x									Fan, Tube, Axial	981619-1
B2		x									Fan, Tube, Axial	981619-1
B3		x									Fan, Tube, Axial	981619-1
B4		x									Fan, Tube, Axial	981619-2
B1			x		x						Fan	91-1605
Capacitors (uF Unless Noted)												
C1	x			x		x		x			0.1, 600V	24-2410-13
		x	x		x	x		x		x	0.68, 1000V	24-2411-12
C2	x	x	x	x	x	x	x	x	x	x	0.1, 200V	24-2409-13
C3	x			x		x		x			0.1, 600V	24-2410-13
		x	x		x	x	x		x	x	0.68, 1000V	24-2111-12
C4	x	x	x	x	x	x	x	x	x	x	0.1, 200V	24-2409-13
C5	x			x		x		x			0.1, 600V	24-2410-13
		x	x		x	x		x		x	0.68, 1000V	24-2111-12
C6	x	x	x	x	x	x	x	x	x	x	0.1, 200V	24-2409-13
C7	x										115K, 25V (6 Required)	24-2549
		x									160K, 25V (6 Required)	24-2544-12
			x								115K, 25V (18 Required)	24-2549
				x		x					56K, 50V	24-2548
					x						56K, 50V (6 Required)	24-2548
						x					5K, 200V (3 Required)	24-2467-5
							x				5K, 200V (5 Required)	24-2467-5
								x			2.2K, 350V (2 Required)	24-2470-5
									x		2.2K, 350V (3 Required)	24-2470-5
C8	x	x	x	x	x	x	x			x	1.7K, 300V (4 Required)	24-2470-3
									x		0.22, 200V	24-2409-15
									x		0.22, 400V	24-2411-15
C14	x			x	x	x				x	0.02, 900 Vac	24-026
		x	x				x	x	x	x	25,25V	235-7404P11
C28	x			x		x		x			Not Used	
		x	x		x		x				0.33, 400V	166374-10
C29	x			x		x			x	x	0.22, 1000V	983970-1
		x	x		x		x				0.33, 400V	166374-10
C30	x			x		x			x	x	0.22, 1000V	983970-1
		x	x		x		x				0.33, 400V	166374-10
C31		x			x		x			x	0.22, 1000V	983970-1
	x			x	x	x	x		x	x	Not Used	
			x	x	x						0.05, 500V	24-2010
											0.02, 900V	24-026

Table 6-1 (Cont'd)
Replaceable Parts List
DCR-A Main Assembly

Circuit Symbol	DCR-A Model										Description	Sorensen Part No.
	20-250	20-500	20-1000	40-125	40-250	40-500	150-35	150-70	300-18	300-35	600-18	
C32	x	x	x	x	x	x	x		x	x	x	Not Used 0.05, 500V 0.02, 900V 24-2010 24-026
C33	x	x	x	x	x	x	x		x	x	x	Not Used 0.05, 500V 0.02, 900V 24-2010 24-026
C34	x	x	x	x	x	x	x		x	x	x	Not Used 0.05, 500V 0.02, 900V 24-2010 24-026
C35	x	x	x	x	x	x	x		x	x	x	Not Used 0.05, 500V 0.02, 900V 24-2010 24-026
C36	x	x	x	x	x	x	x		x	x	x	Not Used 0.05, 500V 0.02, 900V 24-2010 24-026
C37	x	x	x	x	x				x	x	x	1.0, 200V 2.0, 200V 0.33, 400V 0.1, 600V 24-2409-19 24-2409-21 24-2411-16 24-2410-13
C38	x	x	x	x	x				x	x	x	1.0, 200V 2.0, 200V 0.33, 400V 0.1, 600V 24-2409-19 24-2409-21 24-2411-16 24-2410-13
C39	x	x	x	x	x				x	x	x	2.0, 330V 2.0, 660V 1058531-1 24-369
C40	x	x	x	x	x				x	x	x	2.0, 330V 3.0, 660V 1058531-1 24-369
C41	x	x	x	x	x				x	x	x	2.0, 330V 3.0, 660V 1058531-1 24-369
CB1	x	x	x	x	x				x	x	x	Circuit Breaker Circuit Breaker Circuit Breaker 92-346 92-348 92-349
CR1	x	x	x	x	x				x	x	x	C145E 26-1047
CR2	x	x	x	x	x				x	x	x	C145P 1N1190 26-1031 587382-5
CR3	x	x	x	x	x				x	x	x	1N3768 1N1189 26-1024 C145E 26-1047
CR4	x	x	x	x	x				x	x	x	C145P 1N1190 587382-5 1N3768 588853-1
CR5	x	x	x	x	x				x	x	x	1N1189 26-1024 C145E 26-1047 C145P 26-1031

Table 6-1 (Cont'd)
Replaceable Parts List
DCR-A Main Assembly

Circuit Symbol	DCR-A Model											Description	Sorensen Part No.
	20-250	20-500	20-1000	40-125	40-250	40-500	150-35	150-70	300-78	300-35	500-78		
CR6	x			x					x			1N1190	587382-5
		x	x		x	x		x		x	x	1N3768	588853-1
CR7,9, 11	x						x					1N1189	26-1024
		x										1N4587R	587571-3
			x									1N4044	588513-1
				x	x							1261FLR	26-1093
						x						1N4588R	587571-4
							x					MR1245SLR	165019-2
								x				1N1190AR	587382-10
									x			1N1188AR	587382-9
									x			1N3673AR	587393-12
										x		1N3766R	587382-13
CR8,10 12	x										x	1N3671AR	687393-11
		x										1N4587	587571-1
			x									1N4044R	588513-2
				x	x							1261FL	26-1092
						x						1N4588	587571-2
							x					MR1245SL	165019-1
								x				1N1190A	587382-5
									x			1N1188A	587382-4
										x		1N3637A	587393-10
											x	1N2766	687382-11
CR13	x	x	x	x	x	x	x	x	x	x	x	1N3671AR	587393-11
CR14	x	x	x	x	x	x	x	x	x	x	x	RD5637	26-1017
CR15	x	x	x	x	x	x	x	x	x	x	x	RD5637	26-1017
CR27	x	x	x	x	x	x	x	x	x	x	x	RD5637	26-1017
DS1	x	x	x	x	x	x	x	x	x	x	x	1N5243B, Zener, 12V	588101-9
DS2	x	x	x	x	x	x	x	x	x	x	x	Lamp, 1829, 28V	277-1001P11
DS3	x	x	x	x	x	x	x	x	x	x	x	Lamp, 1302, 6.3V	42-341
DS4	x	x	x	x	x	x	x	x	x	x	x	Lamp, NE51	42-301
XDS1	x	x	x	x	x	x	x	x	x	x	x	Lamp, 1302, 6.3V	42-341
XDS2	x	x	x	x	x	x	x	x	x	x	x	Lampholder, Amber	43-322
XDS3	x	x	x	x	x	x	x	x	x	x	x	Lampholder, Green	43-341
XDS4	x	x	x	x	x	x	x	x	x	x	x	Lampholder, Red	42-383
L1	x			x			x		x			Lampholder, Amber	43-322
		x			x			x		x		Choke, RFI	127-1748
			x			x			x		x	Choke, RFI	127-1754
L2	x			x					x			Choke, RFI	127-1761
		x			x			x		x		Choke, RFI	127-1748
			x			x						Choke, RFI	127-1754
L3	x			x			x		x			Choke, RFI	127-1761
		x			x			x			x	Choke, RFI	127-1748
			x				x			x		Choke, RFI	127-1754
					x							Choke, RFI	127-1761

Table 6-1 (Cont'd)
Replaceable Parts List
DCR-A Main Assembly

Circuit Symbol	DCR-A Model										Description	Sorensen Part No.
	20-250	20-500	20-1000	40-125	40-250	40-500	150-35	150-70	300-18	300-35		
L4	x										Filter Choke	127-1759
		x									Filter Choke	166154-1
			x								Filter Choke	127-1809
				x							Filter Choke	127-1757
					x						Filter Choke	127-1755
						x					Filter Choke	982290-1
							x				Filter Choke	127-1804
								x			Filter Choke	127-1807
									x		Filter Choke	127-1805
										x	Filter Choke	127-1806
										x	Filter Choke	127-1808
M1	x				x						300A	94-462-21
		x				x					600A	94-462-22
			x								1200A	94-462-23
				x							150A	94-462-14
						x				x	50A	94-462-20
							x				80A	94-462-19
								x		x	20A	94-462-5
M2	x	x	x		x	x					25V	94-579-2
				x	x	x					50V	94-579-3
							x	x			200V	94-579-6
									x	x	400V	94-579-7
										x	800V	94-579-8
											RESISTORS (Ohms)	
R1	x	x	x	x	x	x	x	x	x	x	0.16, 175W	27-1071
R2	x	x	x	x	x	x	x	x	x	x	0.16, 175W	27-1071
R3	x	x	x	x	x	x	x	x	x	x	0.16, 175W	27-1071
R4	x	x	x	x	x	x	x	x	x	x	33, 2W	280-1147P20
R6	x	x	x	x	x	x	x	x	x	x	33, 2W	280-1147P20
R8	x	x	x	x	x	x	x	x	x	x	33, 2W	280-1147P20
R10A	x	x	x								3, 225W	27-1073
				x	x	x					12, 225W	27-1075
							x	x			100, 100W	27-1009
									x	x	1.5K, 100W	27-1030
R10B	x	x	x	x	x	x					Not Used	
							x	x			100, 100W	27-1009
									x	x	1.5K, 100W	27-1030
R10C	x	x	x	x	x	x	x	x	x		Not Used	
										x	1.5K, 100W	27-1030
R10D	x	x	x	x	x	x	x	x	x		Not Used	
										x	1.5K, 100W	27-1030
R11A	x	x	x		x	x					2, 225W	27-1072
				x							8, 225W	27-1074
						x	x				50, 100W	27-856
								x	x	x	250, 100W	27-831

Table 6-1 (Cont'd)
Replaceable Parts List
DCR-A Main Assembly

Circuit Symbol	DCR-A Model										Description	Sorensen Part No.
	20-250	20-500	20-1000	40-125	40-250	40-500	150-35	150-70	300-18	300-35	600-18	
R11B	x	x		x	x	x					Not Used	
			x				x	x			2, 225W	27-1072
											50, 100W	27-856
R11C	x	x		x	x	x	x		x	x	250, 100W	27-831
			x								Not Used	
								x			2, 225W	27-1072
											50, 100W	27-856
R11D	x	x		x	x	x	x			x	250, 100W	27-831
			x								Not Used	
								x			2, 225W	27-1072
											50, 100W	27-856
R12	x			x					x	x	250, 100W	27-831
		x				x					Shunt, 300A	94-013
			x								Shunt, 600A	94-014
				x							Shunt, 1200A	94-044
								x			Shunt, 150A	94-041
											Shunt, 80A	588151-4
R13A	x					x		x	x	x	Not Used	
		x									0.0013	190-3600
			x								0.0013	165719-1
				x							0.0013	589198-1
					x						0.0026	190-3599
						x					0.0013	190-3607
							x				0.0013	190-3668
								x			0.0083	190-3851
									x		0.00416	190-3861
											0.016	190-3852
									x		0.0083	190-3866
R13B	x			x	x	x	x	x	x	x	0.016	190-3867
		x									Not Used	
			x								0.0013	165719-2
R13C	x	x		x	x	x	x	x	x	x	0.0013	589198-1
			x								Not Used	
R13D	x	x		x	x	x	x	x	x	x	0.0013	589198-1
			x								Not Used	
R24	x	x	x	x	x	x	x	x	x	x	0.0013	589198-1
R41	x	x	x	x	x	x	x	x	x	x	150, 2W, Variable	29-391
R42	x	x	x	x	x	x	x	x	x	x	3K, 2W, Variable	29-408
R55	x	x	x	x	x	x	x	x	x	x	150, 2W, Variable	29-391
R71	x	x	x	x	x	x	x	x	x	x	5.1K, 2W	280-1147P99
R73	x	x	x	x	x	x	x	x	x		150, 1W	280-1180P44
										x	Not Used	
											0.3, 160W	27-1064

Table 6-1 (Cont'd)
Replaceable Parts List
DCR-A Main Assembly

Circuit Symbol	DCR-A Model										Description	Sorensen Part No.
	20-250	20-500	20-1000	40-125	40-250	40-500	150-35	150-70	300-18	300-35	600-18	
R75	x	x	x	x	x	x	x	x			Not Used 750, 25W 750, 100W 2.5K, 100W Thermostat, KLIXON	27-751 27-1029 27-1031 92-516 92-510 92-520 92-515 91-1286 92-512
S1	x	x		x	x					x		
			x									
				x								
						x				x	x	
							x					
S2	x			x	x			x				Not Used Thermostat, KLIXON
		x										92-516 92-510 92-520 92-515
			x									
				x								
S3	x	x	x	x			x	x	x	x	x	Not Used Thermostat, KLIXON
							x	x	x	x		91-1286 92-510
S4	x	x	x	x			x		x			Not Used Thermostat, KLIXON
												92-510 91-1286
		x	x	x	x	x	x	x	x	x	x	
S5	x		x	x	x	x	x	x	x	x	x	Not Used Thermostat, KLIXON
		x										92-510
T1,2 & 3	x	x										Transformer, Rect. Input
			x									126-2832 166152-1 126-3039 126-2831 586466-1 126-3119 126-3030 126-3034 126-3033
				x								
					x							
						x						
							x					
								x				
T4	x			x			x		x		x	Transformer, Control
		x	x		x	x		x		x	x	126-2830 126-2856 126-2829
T5	x			x								Transformer, Fan
		x										166156-1 126-2874 126-2855 126-3031
			x			x				x	x	
				x								
T6	x	x	x	x	x	x	x	x	x	x	x	Transformer, Pulse
T7	x	x	x	x	x	x	x	x	x	x	x	Transformer, Pulse
T8	x	x	x	x	x	x	x	x	x	x	x	Transformer, Pulse
T9	x	x		x	x		x	x	x	x	x	Not Used Transformer, Fan
			x			x						126-2874

Table 6-1 (Cont'd)
Replaceable Parts List
DCR-A Main Assembly

Circuit Symbol	DCR-A Model										Description	Sorensen Part No.
	20-250	20-500	20-1000	40-125	40-250	40-500	150-35	150-70	300-18	300-35	600-18	
TB1	x	x	x	x	x	x	x	x	x	x	Terminal Strip	587924-104
												42-055
												42-090
												90-3544
TB2	x	x	x	x	x	x	x	x	x	x	Terminal Strip	43-082-2
												247-7198P107
												43-082-1
												43-038-3
TB3	x	x	x	x	x	x	x	x	x	x	Terminal Lug (2 Req'd)	4-599
												4-902
												4-426
												587924-1
												4-420
TB4	x	x	x	x	x	x	x	x	x	x	Terminal Lug (2 Req'd)	247-7204P3
												587924-3
												40-3749
												40-3461
	x	x	x	x	x	x	x	x	x	x	MISCELLANEOUS	
											Handle (2 Req'd)	30-634
											Not Used	
											Name Plate	73-2012
												166261-1
												73-2377
												73-2066
												73-2014
												73-2013
												73-2528
												73-2564
												73-2529
												73-2548
												73-2547
	x	x	x	x	x	x	x	x	x	x	Name Plate Decal	73-2065
												73-2064
	x	x	x	x	x	x	x	x	x	x	Bushing, Bakelite	42-947
												43-1087
												43-1091
											Not Used	
												42-931
												43-1091
												42-947
												43-1087
												42-931
												43-1087
												42-931
												43-1091

Table 6-1 (Cont'd)
Replaceable Parts List
DCR-A Main Assembly

Circuit Symbol	DCR-A Model										Description	Sorensen Part No.	
	20-250	20-500	20-1000	40-125	40-250	40-500	150-35	150-70	300-18	300-35			600-18
						x						Bushing, Bakelite (Cont'd)	42-947
						x						Not Used	
							x						42-931
							x						42-934
								x					42-932
								x					42-947
									x				42-931
									x				42-947
										x			42-931
										x			42-932
	x	x	x	x	x	x	x	x	x	x	x	Foot, Aluminum (4 Req'd)	30-657
	x			x		x		x				Cover, Top	73-1494
		x			x		x		x	x			73-1404
			x			x						Not Used	
	x			x		x		x				Cover, Bottom	73-1372
		x			x		x		x	x			73-1548
			x			x						Not Used	
	x			x		x		x				Panel, Rear Left Side	73-1495
		x											166259-1
			x			x						Not Used	
				x			x		x	x			73-1547
	x			x		x		x				Panel, Rear Right Side	73-1496
		x					x						73-1547
			x			x						Not Used	
				x					x				73-1560
										x			73-2908
	x			x		x		x				Cover, Exhaust	73-1497
		x			x		x		x	x			73-1409
			x			x						Not Used	
	x			x								Cover, Intake	73-1498
		x											73-1409
			x			x						Not Used	
				x			x		x	x			73-2415
	x											Front Panel	73-1367-1
		x											165744-1
			x										73-2595
				x									73-1367-2
					x								73-1391
						x							73-1441
							x						73-2527-1
								x					73-2539-3
									x				73-2527-2
										x			73-2539-2
											x		73-2569-1
	x	x	x	x	x	x	x	x	x	x	x	Knob, Control (3 Req'd)	42-277

**Table 6-1 (Cont'd)
Replaceable Parts List
DCR-A Main Assembly**

Circuit Symbol	DCR-A Model										Description	Sorensen Part No.
	20-250	20-500	20-1000	40-125	40-250	40-500	150-35	150-70	300-18	300-35	600-18	
	x	x	x	x	x	x	x	x	x	x	x	OVP Circuit (Optional) VP-18 VP-24 ----- VP-19 ----- VP-20 VP-21 VP-22

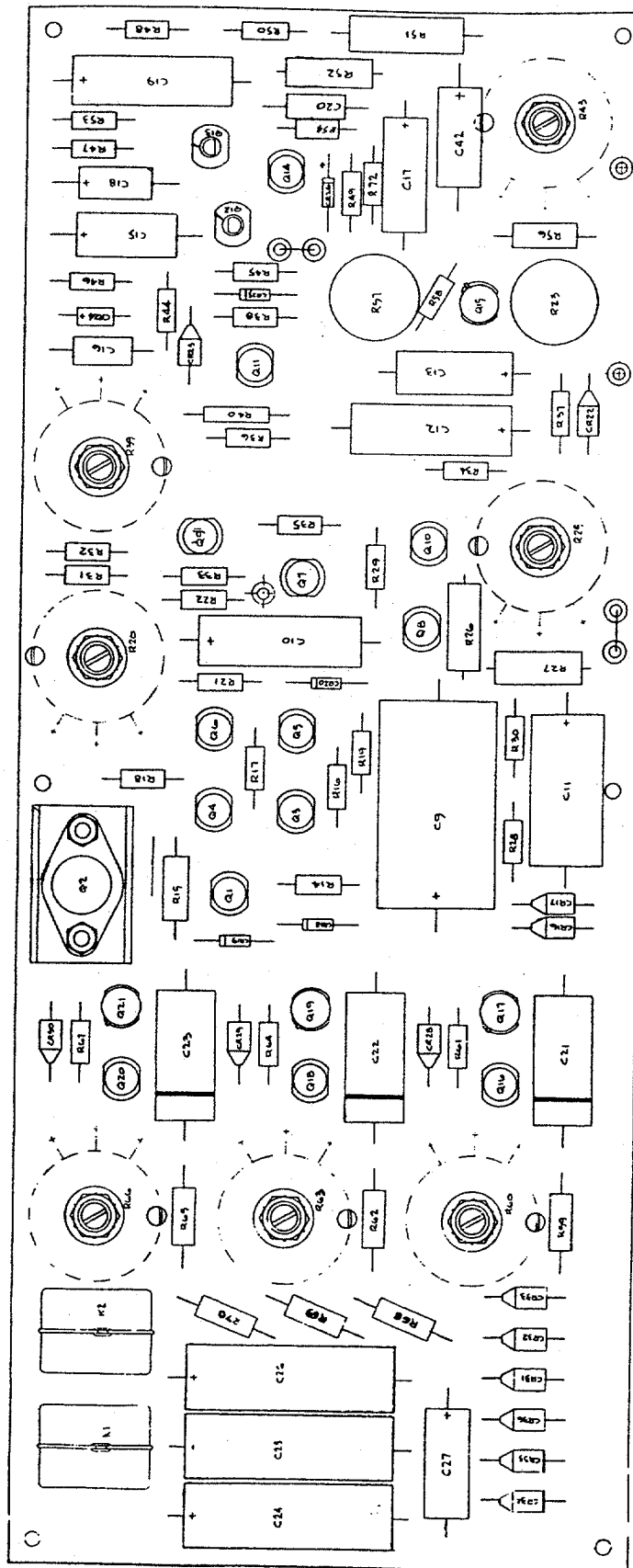


Figure 6-12 P/N 190-3598 PCB Component Location
(Typical of Models 20-250, 20-500, 40-125, 40-250, and 40-500)

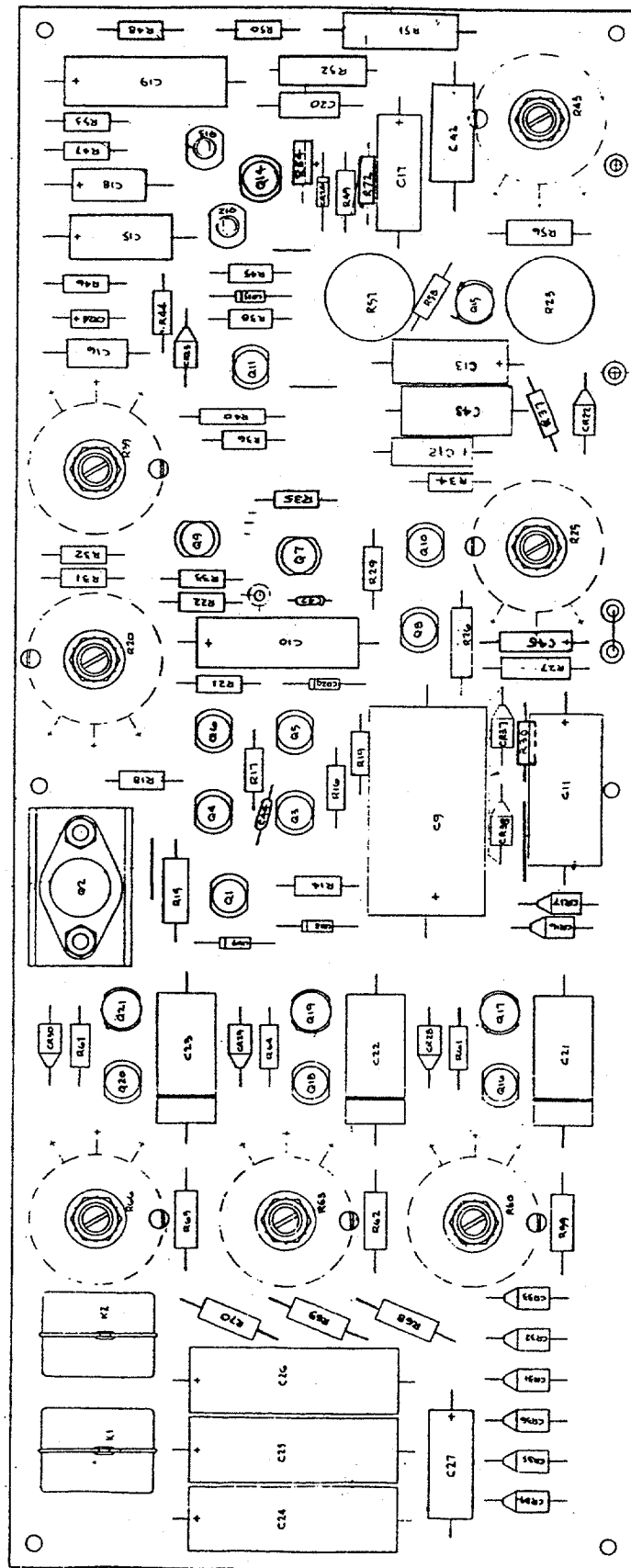


Figure 6-13 P/N 190-3849 PCB Component Location
(Typical of Models 20-1000, 150-35, 150-70, 300-18, 300-35, and 600-18)

Table 6-2
Replaceable Parts List
PCB Assembly

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
	<u>Capacitors (uF unless noted)</u>	
C9	250, 50V	24-2556-3
C10	25, 75V	235-7404P11
C11	100, 25V	235-7404P8
	50, 75V (20-1000 only)	235-7404P5
C12	20, 16V (20-250, 20-500, 40-125, 40-250, 40-500 only)	235-7404P33
	50, 15V (20-1000, 150-35, 150-70, 300-18, 300-35, 600-18 only)	235-7404P15
C13	100, 16V	235-7404P16
C15	35, 25V	235-7404P36
C16	.01, 200V	24-2409-7
C17	100, 16V	235-7404P16
C18	4, 25V	235-7404P35
	4, 50V (40-500 only)	235-7404P38
C19	25, 75V	235-7404P11
C20	.01, 200V	24-2409-7
C21	.22, 200V	24-2409-15
C22	.22, 200V	24-2409-15
C23	.22, 200V	24-2409-15
C24	75, 75V	24-2457-2
C25	75, 75V	24-2457-2
C26	75, 75V	24-2457-2
C27	50, 50V	235-7404P22
C42	35, 25V (20-250, 20-500, 20-1000 only)	235-7404P36
	100, 25V (300-18, 300-35 only)	235-7404P8
C43	.10, 200V (150-35, 150-70, 300-18, 300-35, 600-18 only)	24-2409-13
	.001, 1 kV (20-250, 20-500, 40-125, 40-250, 40-500 only)	235-7207P16
C44	.01, 300V (20-1000, 150-35, 150-70, 300-18, 300-35, 600-18 only)	235-7361P2
C45	50, 15V (20-1000 only)	235-7404P15
	25, 75V (150-35, 150-70, 600-18 only)	235-7404P11
C47	.01, 300V (20-1000 only)	235-7361P2
C48	.001, 1 kV (20-1000, 150-35, 150-70, 300-18, 300-35, 600-18 only)	235-7207P16
	<u>Diodes</u>	
CR16	S11	587565-1
CR17	S11	587565-1
CR18	RD5637	26-1017
CR19	RD5637	26-1017
CR20	1N750A, Zener, 4.7V	26-211

Table 6-2 (Cont'd)
Replaceable Parts List
PCB Assembly

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
CR22	S11	587565-1
CR23	S11	587565-1
CR24	1N6226B, Zener, 5.6V	588101-3
CR25	RD5637	26-1017
CR26	RD5637	26-1017
CR28	1N4747A, Zener, 20V	588102-13
CR29	1N4747A, Zener, 20V	588102-13
CR30	1N4747A, Zener, 20V	588102-13
CR31	S12	587565-2
CR32	S12	587565-2
CR33	S12	587565-2
CR34	S11	587565-1
CR35	S11	587565-1
CR36	S11	587565-1
CR37	S11 (150-35, 150-70, 300-18, 300-35, 600-18 only)	587565-1
CR38	S11 (150-35, 150-70, 300-18, 300-35, 600-18 only)	587565-1
K1	Relay	92-924
K2	Relay	92-924
XK1	Socket, Relay	42-175
XK2	Socket, Relay	42-175
<u>Transistors</u>		
Q1	RT9338	18-146
Q2	40312	18-142
Q3	PN3641	18-144
Q4	PN3641	18-144
Q5	PN3641	18-144
Q6	PN3641	18-144
Q7	2N3638	18-143
Q8	2N3638	18-143
Q9	2N3638	18-143
Q10	2N3638	18-143
Q11	2N3638	18-143
Q12	2N2926, Selected	386-7214P6
Q13	2N2926, Selected	386-7214P6
Q14	PN3641	18-144
Q15	2N2219A	386-7249P32
Q16	2N3638	18-143
Q17	2N2647	18-153
Q18	2N3638	18-143
Q19	2N2647	18-153
Q20	2N3638	18-143
Q21	2N2647	18-153

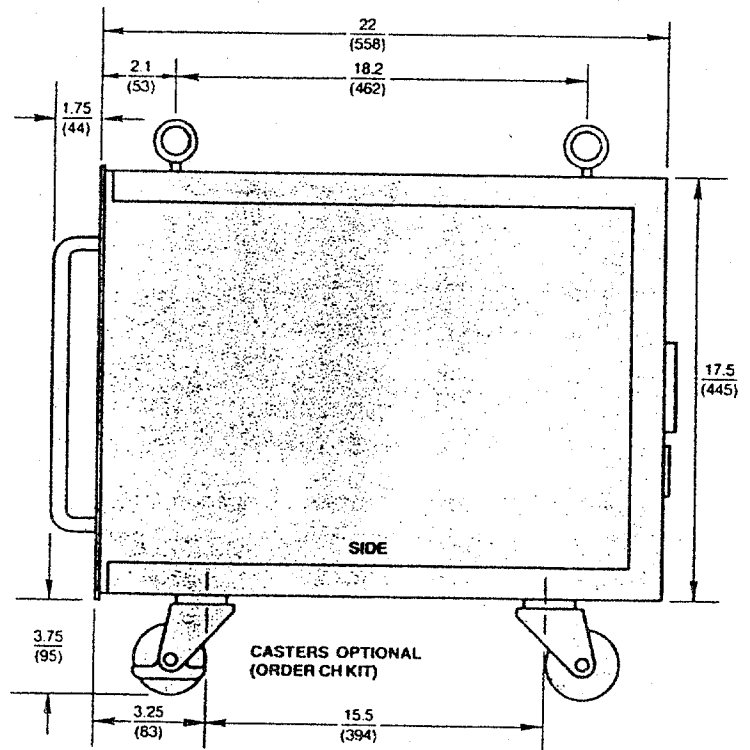
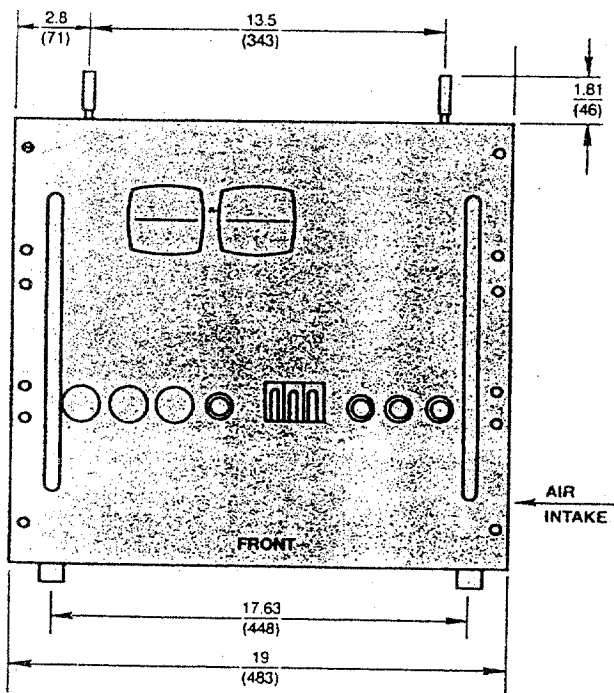
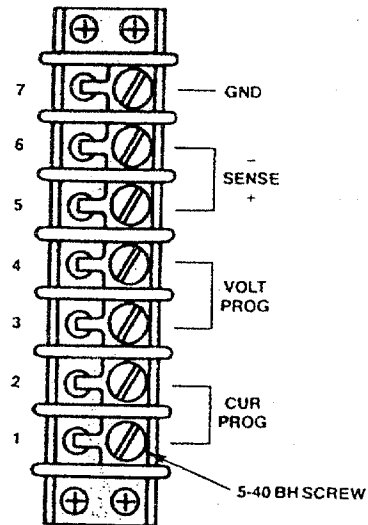
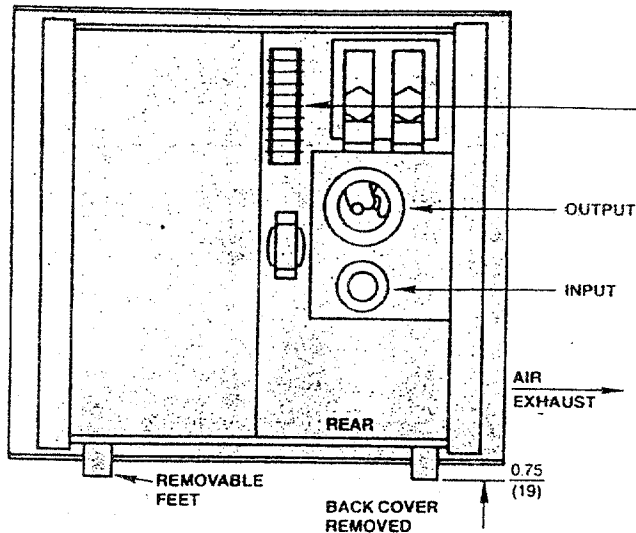
Table 6-2 (Cont'd)
Replaceable Parts List
PCB Assembly

Symbol	Description	Part Number
	<u>Resistors</u> (Ohms, 1/2W, 10% unless noted)	
R14	100	280-1145P38
R15	680, 2W	280-1147P68
R16	1.2K, 5%	280-1145P76
R17	1K	280-1145P74
R18	1K	280-1145P74
R19	1K	280-1145P74
R20	1K, 2W, Variable	29-406
R21	680	280-1145P68
R22	2.2K	280-1145P86
R23	500, 2W, Variable	29-450
R25	10K, 2W, Variable	29-493
R26	3.9K, 1%	28-1145
R27	221, 1%	28-1188
R28	100 (20-250, 20-500, 40-125, 40-250, 40-500 only)	280-1145P38
R29	1K	280-1145P74
R30	4.7K, 5%	280-1145P98
R31	681, 1/4W, 1%	28-1224
R32	332, 1/4W, 1%	28-1223
R33	10K, 1/4W, 1%	28-1226
R34	330	280-1145P56
R35	680	280-1145P67
R36	330	280-1145P56
R37	330	280-1145P56
R38	1K	280-1147P74
R39	2K, 2W, Variable	29-407
R40	475, 1/4W, 1%	28-1166
R43	4K, 2W, Variable (20-250, 20-500, 20-1000 only)	29-475
	2K, 2W, Variable (40-125, 40-250, 40-500 only)	29-407
	1k, 2W, Variable (150-35, 150-70, 300-18, 300-35 only)	29-406
	150, 2W, Variable (600-18 only)	29-531
R44	470	280-1145P62
R45	4.7K, 5%	280-1145P98
R46	68K	280-1145P140
R47	2.2K	280-1145P86
R48	6.8K	280-1145P104
R49	182, 1/4W, 1%	28-1222
R50	2.7K	280-1145P89
R51	2K, 5W (20-250, 20-500, 20-1000 only)	28-1200
	4.7K, 5W (40-125, 40-250, 40-500, only)	28-1150
	15K, 5W (150-35, 150-70 only)	28-1154

Table 6-2 (Cont'd)
Replaceable Parts List
PCB Assembly

Symbol	Description	Part Number
R51 (Cont'd)	29K, 10W (300-18, 300-35 only)	167403-1
	54K, 10W (600-18 only)	167403-2
R52	680 (20-250, 20-500, 20-1000 only)	585326-107
	900, 3W (40-125, 40-250, 40-500 150-35, 150-70, 300-18, 300-35 only)	28-1153
	820, (600-18 only)	585326-111
R53	2K, 1/4W, 1%	28-1225
R54	121, 1/4W, 1%	28-1221
R56	220, 1W	280-1180P50
R57	50, 2W, Variable	29-467
R58	22	280-1145P14
R59	6.8K, 4W, 5%	167155-2
R60	2K, 2W, Variable	29-494
R61	390	280-1145P59
R62	6.8K, 4W, 5%	167155-2
R63	2K, 2W, Variable	29-494
R64	390	280-1145P59
R65	6.8K, 4W, 5%	167155-2
R66	2K, 2W, Variable	29-494
R67	390	280-1145P59
R68	3.3K, 3W, 5%	27-398-10
R69	3.3K, 3W, 5%	27-398-10
R70	3.3K, 3W, 5%	27-398-10
R72	220 (20-250, 20-500, 20-1000 only)	280-1145P50
	2.2K (300-18, 300-35 only)	280-1145P86
	DCR-A Model	PCB Assembly
	20-250A	190-3598-1
	20-500A	190-3598-1
	20-1000A	190-3849-4
	40-125A	190-3598-2
	40-250A	190-3598-3
	40-500A	190-3598-4
	150-35A	190-3849-1
	150-70A	190-3849-1
	300-18A	190-3849-2
	300-35A	190-3849-2
	600-18A	190-3849-3

For rack mounting: order rear mounting support RP9



Input Terminals:

4 terminal barrier strip with 10-32BH Screws

Model

- DCR 150-35A
- DCR 300-18A

Cabinet side enclosures optional for all models (order CSE kit)

- DCR 20-250A
- DCR 40-125A

Weight

lb. kg.

309 140

318 144

309 140

315 143

Output Terminals

Jones' Barrier Terminal Blocks/10-32BH Screws

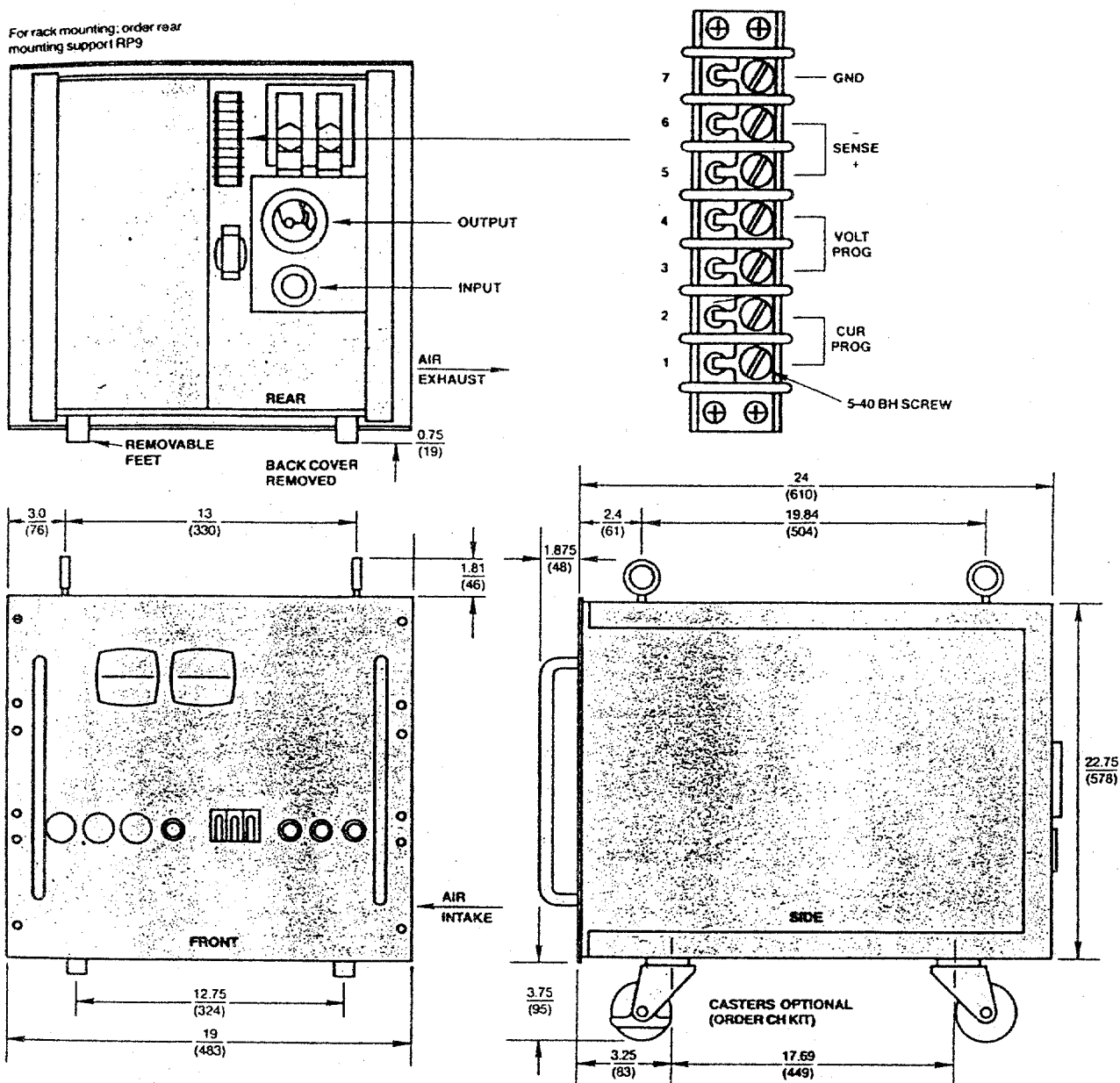
Penn Union #ZE34 post lug terminals for 1/0 to 350 MCM

Note: All dimensions are in inches (mm)

• Limited production. Consult factory for delivery.

Figure 6-14 Outline Drawing 20-250, 40-125, 150-35, 300-18

For rack mounting: order rear
mounting support RP9



Input Terminals:

4 terminal barrier strip with 12-32BH Screws

Model

- DCR 300-35A
- DCR 600-18A
- DCR 20-500A

DCR 40-250A

Cabinet side enclosures optional for all models
(order CSE kit)

• DCR 150-70A

Weight

lb.

kg.

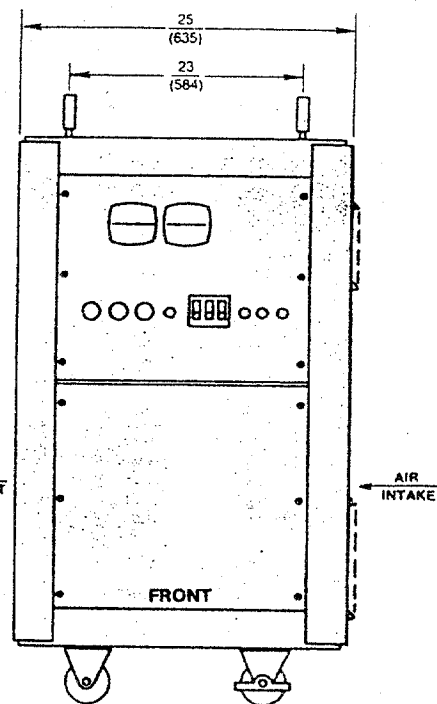
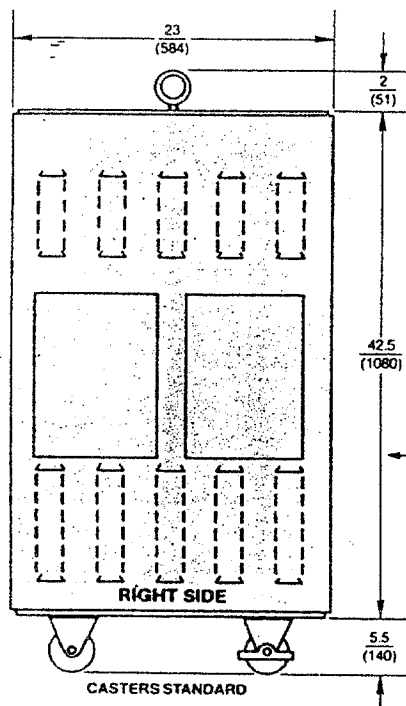
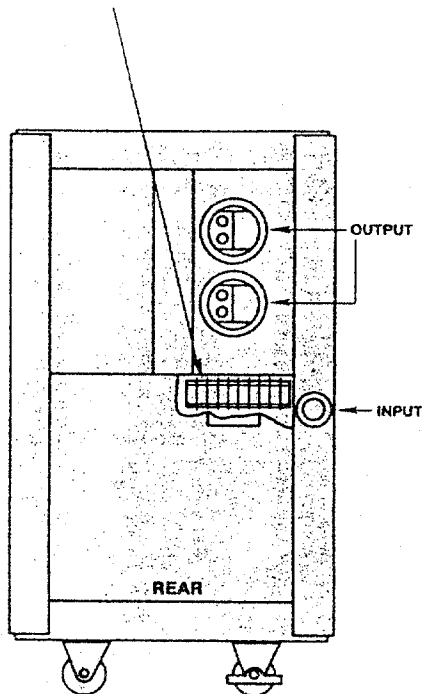
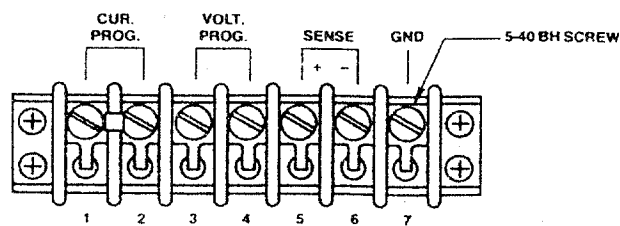
Output Terminals

Jones' Barrier Terminal
Blocks/10-32BH Screws
Penn Union #Hex 21915 post lug terminals for
700MCM to 1000 MCM
Penn Union #ZE34
post lug terminals for 1/0 to 350 MCM
Penn Union #ZE15
post lug terminals for #4 strd. to #1 strd.

Note: All dimensions are in inches
(mm)

• Limited production. Consult factory for delivery.

Figure 6-15 Outline Drawing 20-500, 40-250, 150-70, 300-35, 600-18



Input Terminals:

4 terminals barrier strip (DCR 40-500A - 12-32BH Screws, DCR 20-1000A - 1/4-28BH Screws)

Model

Weight

lb.

kg.

Output Terminals

DCR 20-1000A

850

386

Penn Union #VL2-21925 post lug terminals. Each lug 700 MCM to 1000 MCM (2 wires)

DCR 40-500A

850

386

Penn Union #Hex-21915 post lug terminals for 700 MCM to 1000 MCM

Note: All dimensions are in inches (mm)

Figure 6-16 Outline Drawing 20-1000, 40-500

APPENDIX A OVERVOLTAGE PROTECTOR

A.1 OVERVOLTAGE PROTECTOR

The DCR-A (with the exception of the 20-1000A and 40-500A) is available with a factory installed overvoltage protector which prevents damage to the load at a user selected maximum voltage. Typical loading is 25 mA, response time 10 us, temperature coefficient $-0.05\%/^{\circ}\text{C}$, and ambient temperature 70°C maximum.

Potentiometer R6, in series with differential amplifier Q1-Q2 (with a balance bridge), is across the DCR-A output. The setting of R6 determines the overvoltage trip point. With applied voltage less than the trip point, Q1 is conducting and Q2 is cut off. As the DCR-A voltage approaches the trip point, Q1 gradually cuts off and Q2 conducts, developing a signal across resistor R2 which fires rectifiers CR4 and CR5. A voltage is developed on resistor R8 providing a gate signal to rectifier CR2 which then short circuits the DCR-A output.

On-off recycling of CR2 during current limit operation is prevented by a connection through the DCR-A Q7 stage that drops the output to zero. The overvoltage protector also has a circuit connected to one phase of the three phase circuit breakers on the DCR-A, and is activated by CR4 through R8 to trigger rectifier CR11 which then opens the DCR-A input. Thermostat S1 is a redundant safety feature which will protect CR2 if its temperature rise becomes excessive.

A.2 TRIP LEVEL ADJUSTMENT

To adjust the trip level:

- A. Turn adjustment potentiometer R6 completely clockwise (CW).
- B. Apply power and set the power supply output voltage to the desired trip level.
- C. Slowly rotate VP adjustment potentiometer R6 counterclockwise (CCW) until the output voltage drops.
- D. Remove input power and reduce the DCR-A output voltage setting.
- E. Apply power and adjust the DCR-A voltage control to the desired operating level.

The overvoltage protector is now set to lower the output should the voltage reach the trip level set in step B.

NOTE

Because of the protector's rapid response, peak voltage disturbances due to line or load change, while undamaging to the load, may occasionally cause false triggering. Should false triggering occur, the response time may be slowed down by adding capacitance to C1 and adding capacitance in parallel with R2.

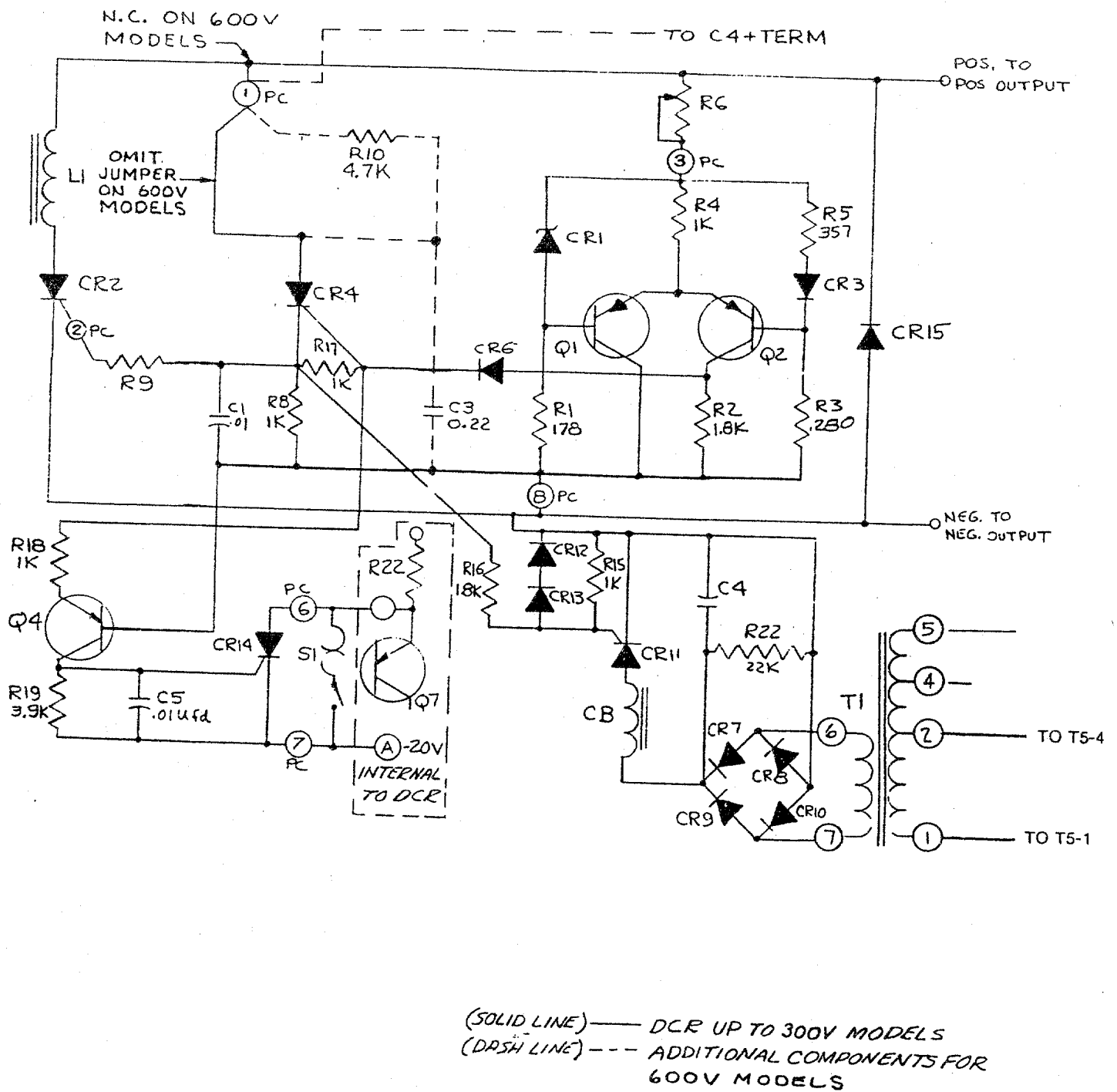


Figure A-1 Overvoltage Protector Schematic Diagram

Table A-1
Replaceable Parts List
Overvoltage Protection Assembly

Circuit Symbol	OVP						Description	Sorensen Part No.
	VP-18	VP-19	VP-20	VP-21	VP-22	VP-24		
							<u>Capacitors</u> (uF unless noted)	
C1	x	x	x	x	x	x	0.01, 250V	24-2015-1
C3	x	x	x	x		x	Not Used	
					x		0.15, 250V	24-2015-15
C4	x	x	x	x	x	x	32, 150V	24-2571-3
C5	x	x	x	x	x	x	0.01, 250V	24-2015-1
							<u>Diodes</u>	
CR1	x	x	x	x	x	x	1N5221B, Zener, 2.4V	588101-1
CR2	x	x	x			x	C290BV	26-1111
				x			C180D	26-1103-4
					x		C180S	26-1103-7
CR3	x	x	x	x	x	x	RD5637	26-1017
CR4	x	x	x		x	x	C106B2	26-1080
				x			C106D21	26-1112-1
CR6	x	x	x	x	x	x	SEN-R-30	587565-3
CR7	x	x	x	x	x	x	SEN-R-29	587565-2
CR8	x	x	x	x	x	x	SEN-R-29	587565-2
CR9	x	x	x	x	x	x	SEN-R-29	587565-2
CR10	x	x	x	x	x	x	SEN-R-29	587565-2
CR11	x	x	x	x	x	x	C106B1	26-1113
CR12	x	x	x	x	x	x	SEN-R-29	587565-2
CR13	x	x	x	x	x	x	SEN-R-29	587565-2
CR14	x	x	x	x	x	x	C106B2	26-1080
CR15	x	x	x				1N3768R	587382-14
				x	x		70HR100A	588853-2
						x	1N1184A	587382-2
L1	x	x	x	x	x	x	Choke	127-1824
Q1	x	x	x	x	x	x	2N3638	18-143
Q2	x	x	x	x	x	x	2N3638	18-143
Q4	x	x	x	x	x	x	2N3638	18-143
							<u>Resistors</u> (Ohms, 1/4W, 10%, unless noted)	
R1	x	x	x	x	x	x	178, 1%	28-1283
R2	x	x	x	x	x	x	1.8K	280-1171P83
R3	x	x	x	x	x	x	280, 1%	28-1284
R4	x	x	x	x	x	x	1K	280-1171P74
R5	x	x	x	x	x	x	357, 1%	28-1285
R6	x					x	3K, 2W, Variable	29-548
		x					6K, 2W, Variable	29-549
			x				24K, 2W, Variable	29-551
				x			2 X 19K, 4W, 2W, Variable	29-552
					x		3 X 24K, 10W	29-557
R8	x	x	x	x	x	x	1K, 1/2W	280-1145P74

Table A-1 (Cont'd)
Replaceable Parts List
Overvoltage Protection Assembly

Circuit Symbol	OVP						Description	Sorensen Part No.
	VP-18	VP-19	VP-20	VP-21	VP-22	VP-24		
R9	x	x	x	x	x	x	10, 1/2W 22, 1/2W 27, 1/2W 47, 1/2W	280-1145P2 280-1145P14 27-1165 280-1145P26
R10	x	x	x	x	x	x	Not Used 4.7K, 1/2W	280-1145P98
R15	x	x	x	x	x	x	1K, 1/2W	280-1145P74
R16	x	x	x	x	x	x	1.8K, 1/2W	280-1145P83
R17	x	x	x	x	x	x	1K, 1/2W	280-1145P74
R18	x	x	x	x	x	x	1K, 1/2W	280-1145P74
R19	x	x	x	x	x	x	3.9K	280-1171P95
R22	x	x	x	x	x	x	22K, 2W	27-307
S1	x	x	x	x	x	x	Thermostat, 15A, 115V	92-522
T1	x	x	x	x	x	x	Transformer	126-3072
							<u>Miscellaneous</u>	
	x	x	x	x	x	x	PCB Assembly	190-3947-1 190-3947-2 190-3947-3 190-3947-4 190-3947-5 190-3944
							<u>Comp. Board Assembly</u>	
							<u>Where Used</u>	
	x	x	x	x	x	x	20-250A 40-125A, 40-250A 150-35A, 150-70A 300-18A, 300-35A 600-18A 20-500A	

APPENDIX B

DCR 20-1000A1

B.1 GENERAL

The DCR 20-1000A1 is an updated version of the DCR 20-1000A. Some items used in the manufacture of the DCR 20-1000A have become unavailable. The engineers at Sorensen have taken this opportunity to improve airflow conditions and to utilize upgraded components in the high current rectifiers.

The specifications remain the same but with increased cooling to provide improved performance and longer life. This Appendix will describe the DCR 20-1000A1 through schematic diagrams, assembly drawings, and parts lists to reflect the changes that have occurred in the design.

All operation and maintainance information for this unit may be found in the standard DCR-A instruction manual, Sorensen document number 1057663.

Table B-1
Parts Location List
Final Assembly, DCR 20-1000A1
1058654-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Bottom Chassis Assembly	1058660-1	
2	Rectifier Assembly	1058720-1	
3	Rear Panel Sub-Assembly	1058630-1	
4	Top Cover Sub-Assembly	1058644-1	
5	Front Panel Sub-Assembly	1058684-2	
6	Circuit Breaker Sub-Assembly	1058672-2	
7	Fastener, Nut, Locking	1058472-1	
8	HHMS, 1/4-20 X 5/8	1058421-17	
10	Panel, Rear Left	73-1592	
11	Bracket, Output Cable	1058661-1	
12	Panel, Rear Bottom	73-2365	
13	Panel, Front	1058692-1	
14	Panel, Right Side	1058619-1	
15	Left Panel Fan Assembly	1058669-2	
16	Plate, Access	73-2378	
17	Buss Bar, Neg to HS	1058658-1	
18	Decal, Nameplate	73-2377	
20	Bushing, Male	43-1091	
28	Clamp	93-247	
29	Jumper Kit (Lead)	1058655-1	
31	Decal	73-2064	
32	HHMS, 1/4-20 X 1	1058421-2	
33	HHMS, 3/8-16 X 1	6-107	
34	PHMS, 6-32 X 5/16	6-2002-24	
35	HHMS, 5/16-18 X 5/8	1058421-37	
36	Nut, Hex, 5/16-18	1058472-2	
37	PHMS, 10-32 X 1/2	6-2000-44	
38	FHMS, 10-32 X 1/2	6-2020-51	
39	FHMS, 10-32 X 1/2	6-2020-51	
43	Washer, Flat, 3/8	6-4001-10	
47	Nut, Hex, 10-32	2-362	
49	Nut, Hex, 3/8-16	6-3001-10	
50	Washer, Lock, 3/8	6-4013-10	
51	Connector Cover	1057763-4	

Table B-2
Parts Location List
Rectifier Assembly, DCR 20-1000A1
1058620-1

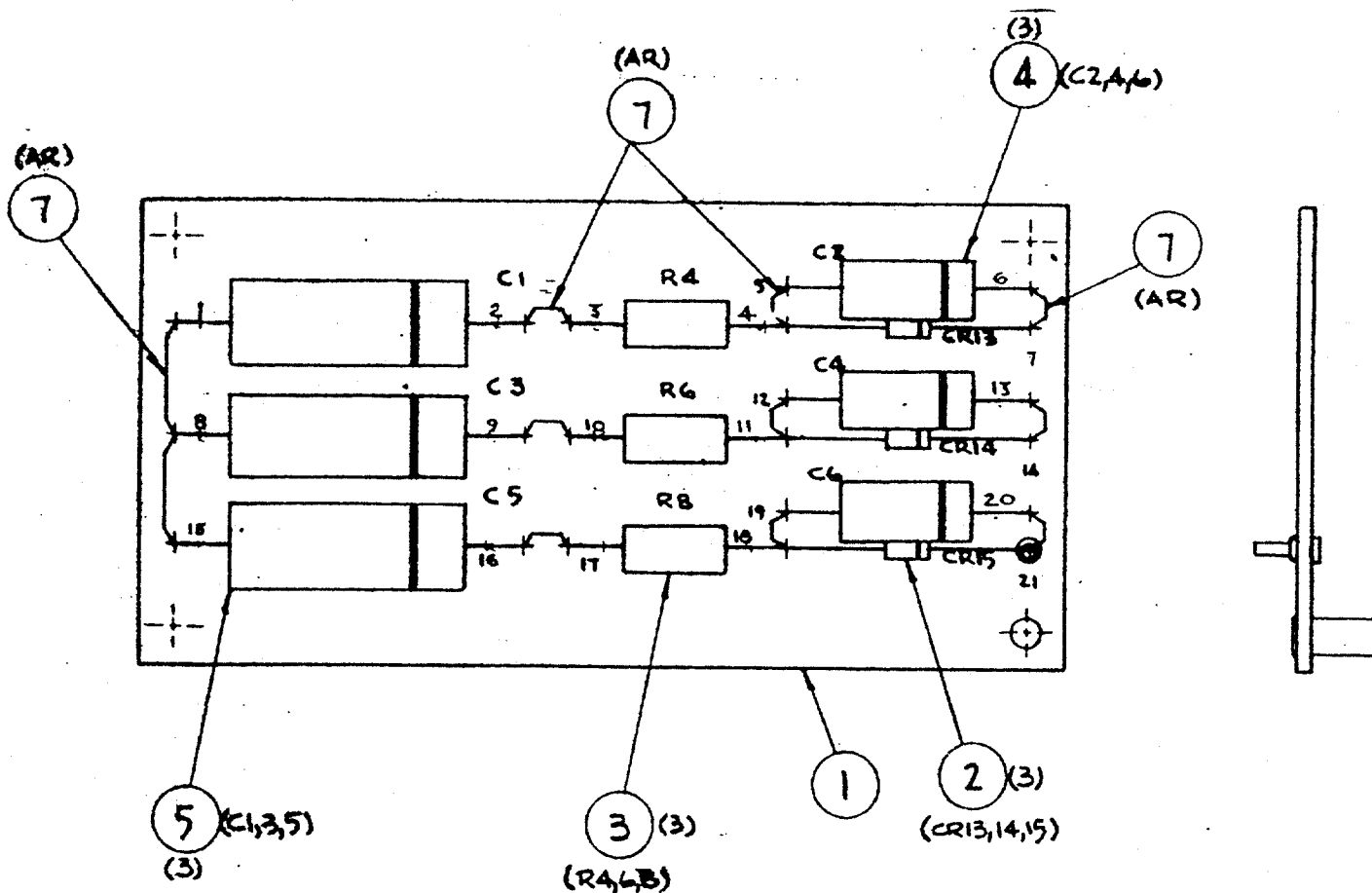
<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Diode, PDA 6BFR7MRV20	1058581-1	
2	Buss Bar, Neg Out	1058621-1	
3	Buss Bar	1058622-1	
4	Buss Bar To Lead	1058623-1	E50
	Buss Bar To Lead	1058623-1	E51
5	Insulator Bar	1058624-1	
6	Heatsink Sub-Assembly	1058625-1	
7	Buss Bar	1058627-1	
8	Buss Bar, T1 Output	1058628-1	
9	Bracket, Left	1058629-1	
10	Bracket, Right	1058629-2	
11	Thermo, 24V, 2400W	1058402-2	S1
	Thermo, 24V, 2400W	1058402-2	S2
	Thermo, 24V, 2400W	1058402-2	S5
12	HHMS, 5/16-18 X 1	6-2010-24	
13	Washer, Flat, 5/16	6-4001-9	
14	Nut, Hex, 5/16-18	1058472-2	
15	HHMS, 5/16-18 X 5/8	1058421-37	
16	L Spacer	30-060-139	
17	PHMS, 10-32 X 7/8	6-2002-58	
18	Washer, Lock, #10	6-4012-5	
19	Washer, Flat, #10	6-4000-6	
20	Nut, Hex, 6-32	2-360	
21	HHMS, 5/16-18 X 1	1058421-8	
24	Clamp, Cable	168733-1	
26	Retainer, Nylon	362-7195P2	

Table B-3
Replaceable Parts List
Heat Sink Sub-Assembly, DCR 20-1000A1
1058625-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
CR1	Diode, C145P	26-1031
CR2	Diode, 1N3768	588853-1
CR3	Diode, C145P	26-1031
CR4	Diode, 1N3768	588853-1
CR5	Diode, C145P	26-1031
CR6	Diode, 1N3768	588853-1
S3	Thermostat	92-510
S4	Thermostat	91-1286
TB4	Terminal Board	40-3749
TB17	Terminal Block, 2, 30A	247-7204P2

Table B-4
Parts Location List
Heat Sink Sub-Assembly, DCR 20-1000A1
1058625-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Bracket, Heat Sink	1058626-1	
2	Terminal Board	40-3749	TB4
3	Bracket, Heat Sink	73-2478	
4	Heat Sink	91-1805	
5	Heat Sink, Extruded Aluminum	91-1807-1	
6	Component Board Assembly	190-3868	
7	Diode, 1N3768	588853-1	CR2
	Diode, 1N3768	588853-1	CR4
	Diode, 1N3768	588853-1	CR6
8	Diode, C145P	26-1031	CR1
	Diode, C145P	26-1031	CR3
	Diode, C145P	26-1031	CR5
9	Thermostat	91-1286	S4
10	Thermostat	92-510	S3
11	Lug, #6	4-114	
12	Washer, Flat, #2	6-4000-2	
13	PHMS, 2-56 X 1/4	6-2001-56	
14	PHMS, 4-40 X 3/8	6-2001-58	
15	PHMS, 6-32 X 3/8	6-2001-13	
16	PHMS, 6-32 X 1/2	6-2001-14	
17	PHMS, 8-32 X 7/8	6-2001-83	
18	PHMS, 10-32 X 1	6-2001-37	
19	HHMS, 1/4-20 X 1/2	6-2010-13	
20	Washer, Flat, #6	6-4000-4	
21	Washer, Flat, #8	6-4000-5	
22	Washer, Flat, #10	6-4000-6	
23	Washer, Lock, Split, 1/4	6-4013-8	
24	Washer, Lock, #2	6-4012-1	



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Figure B-5 Component Board Assembly, DCR 20-1000A1, Assembly Drawing

Table B-5
 Replaceable Parts List
 Component Board Assembly, DCR 20-1000A1
 190-3868

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
C1	Cap, .68 uF, 1000V	24-2111-12
C2	Cap, .1 uF, 200V	24-2409-13
C3	Cap, .68 uF, 1000V	24-2111-12
C4	Cap, .1 uF, 200V	24-2409-13
C5	Cap, .68 uF, 1000V	24-2111-12
C6	Cap, .1 uF, 200V	24-2409-13
CR13	Diode, RD5637	26-1017
CR14	Diode, RD5637	26-1017
CR15	Diode, RD5637	26-1017
R4	Res, 33, 2W	280-1147P20
R6	Res, 33, 2W	280-1147P20
R8	Res, 33, 2W	280-1147P20

Table B-6
Replaceable Parts List
Rear Panel Sub-Assembly, DCR 20-1000A1
1058630-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
C8	Cap, .22 uF, 200V	24-2409-15
C28	Cap, .22 uF, 1 kV	983970-1
C29	Cap, .22 uF, 1 kV	983970-1
C30	Cap, .22 uF, 1 kV	983970-1
C37	Cap, 2.0 uF, 200V	24-2409-21
C38	Cap, 2.0 uF, 200V	24-2409-21
E6	Lug, Solder	4-142
E9	Lug, Solder	4-129
E10	Lug	4-141
E11	Lug	4-141
E13	Lug, Solder	4-142
R1A	Res, 0.16, 175W	27-1071
R1B	Res, 0.16, 175W	27-1071
R1C	Res, 0.16, 175W	27-1071
R1D	Res, 0.16, 175W	27-1071
R2A	Res, 0.16, 175W	27-1071
R2B	Res, 0.16, 175W	27-1071
R2C	Res, 0.16, 175W	27-1071
R2D	Res, 0.16, 175W	27-1071
R3A	Res, 0.16, 175W	27-1071
R3B	Res, 0.16, 175W	27-1071
R3C	Res, 0.16, 175W	27-1071
R3D	Res, 0.16, 175W	27-1071
R13A	Res, 0.0013	589198-1
R13B	Res, 0.0013	589198-1
R13C	Res, 0.0013	589198-1
R13D	Res, 0.0013	589198-1
T4	Transformer	126-2856
T6	Transformer, Pulse	126-2632
T7	Transformer, Pulse	126-2632
T8	Transformer, Pulse	126-2632
TB1	Terminal Board	42-090
TB2	Terminal Strip	43-082-1
TP1	Terminal Strip, Standard	687878-6

Table B-7
Parts Location List
Rear Panel Sub-Assembly, DCR 20-1000A1
1058630-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Panel, Rear	1058631-1	
2	Barrier	73-1587	
3	Bracket, Terminal Board	1058632-1	
4	Insulator, Phenolic	1058634-1	

Table B-7 (Cont'd)
Parts Location List
Rear Panel Sub-Assembly, DCR 20-1000A1
1058630-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
6	Shunt Terminal Board	1058659-1	
7	Support, L-Bracket	1058689-1	
8	Buss Bar	1058636-1	
9	Buss Bar (Jumper)	1058637-1	
10	Buss Bar	1058638-1	
11	Buss Bar Pos Out	1058639-1	
12	Buss Bar Neg Out	1058640-1	
13	Shunt Spacer	73-2472	
14	Buss Bar Pos Out	1058641-1	
15	Buss Bar Conn. Choke	1058642-1	
16	Cable Rear Panel	1058682-1	
17	Main Harness	1058680-2	
18	Jumper Kit DCR 20-1000A1	1058717-1	
19	Shunt	94-044	
20	Res, 0.0013	589198-1	R13A
	Res, 0.0013	589198-1	R13B
	Res, 0.0013	589198-1	R13C
	Res, 0.0013	589198-1	R13D
21	PCB Assembly	1058718-1	A1
22	Transformer, Pulse	126-2632	T6
	Transformer, Pulse	126-2632	T7
	Transformer, Pulse	126-2632	T8
23	Transformer	126-2856	T4
24	Res, 0.16, 175W	27-1071	R1A
	Res, 0.16, 175W	27-1071	R1B
	Res, 0.16, 175W	27-1071	R1C
	Res, 0.16, 175W	27-1071	R1D
	Res, 0.16, 175W	27-1071	R2A
	Res, 0.16, 175W	27-1071	R2B
	Res, 0.16, 175W	27-1071	R2C
	Res, 0.16, 175W	27-1071	R2D
	Res, 0.16, 175W	27-1071	R3A
	Res, 0.16, 175W	27-1071	R3B
	Res, 0.16, 175W	27-1071	R3C
	Res, 0.16, 175W	27-1071	R3D
26	Cap, 2.0 uF, 200V	24-2409-21	C37
	Cap, 2.0 uF, 200V	24-2409-21	C38
27	Cap, .22 uF, 200V	24-2409-15	C8
28	Cap, .22 uF, 1 kV	983970-1	C28
	Cap, .22 uF, 1 kV	983970-1	C29
	Cap, .22 uF, 1 kV	983970-1	C30
29	Lug, #4	4-113	
31	Terminal Board	4-090	TB1
32	Terminal Strip	43-082-1	TB2
33	Lug, Solder	4-129	E9
34	Lug, Solder	4-142	E6

Table B-7 (Cont'd)
Parts Location List
Rear Panel Sub-Assembly, DCR 20-1000A1
10586301-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
	Lug, Solder	4-142	E13
35	Lug	4-141	E10
	Lug	4-141	E11
36	Clamp	93-244	
37	Clamp, Cable	93-401	
38	Tie-Wrap	362-7195P7	
39	Grommet	359-7205P3	
40	Grommet	359-7205P2	
41	Washer, Mica	3-368	
42	Washer, Centering	3-448	
44	PHMS, 10-32 X 1	6-2001-37	
45	PHTF, 6-32 X 3/8	6-2004-21	
47	PHMS, 6-32 X 5/8	6-2001-15	
50	PHMS, 10-32 X 1/2	6-2001-34	
53	Thru-Bolt, 10-32 X 6 3/4	1-9077	
54	PHMS, 1/4-28 X 2	1-9357	
55	PHMS, 1/4-20 X 1	6-2001-47	
56	HHMS, 3/8-16 X 1	6-107	
57	HHMS, 3/8-16 X 4 1/2	6-116	
58	Cap, Screw, Hex Head	6-1149	
59	Strap Mount	93-511	
60	Clamp	362-7195P3	
61	Washer, Flat, #6	6-4000-4	
62	Washer, Flat, #10	6-4000-6	
63	Washer, Split, 1/4	6-4001-8	
64	Washer, Flat, 3/8	6-4001-10	
65	Washer, Flat, 1/2	6-4001-12	
66	Nut, Hex, 6-32	2-360	
68	Nut, Hex, 10-32	2-362	
70	Nut, Hex, 1/4-20	6-3001-8	
71	L-Nut, 1/4-20	2-364	
72	Nut, Hex, 3/8-16	6-3001-10	
73	Nut, Hex, 1/2-13	6-3001-12	
74	Nut, Jam, 1/2-13	2-601	
75	HHMS, 1/4-20 X 1	1058421-2	
76	Washer, Lock, Int. Tooth, 1/4	6-4011-8	
77	Washer, Lock, #6	6-4012-3	
78	Fastener, Nut, Locking	1058472-1	
79	Washer, Lock, Split, 1/4	6-4013-8	
80	Washer, Lock, 3/8	6-4013-10	
81	Washer, Lock, 1/2	6-4013-12	
82	Cable	191-824	
84	Terminal Strip, Standard	587878-6	TP1
85	PHMS, 4-40 X 5/16	6-2001-66	
86	Nut, Locking, 4-40	2-649	
87	PHMS, 10-32 X 3/8	6-2001-33	
89	Washer, Lock, #10	6-4012-5	

Table B-7 (Cont'd)
 Parts Location List
 Rear Panel Sub-Assembly, DCR 20-1000A1
 1058630-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
90	PHMS, 4-40 X 3/8, SS	207-7195P167	
91	Washer, Lock, #4	6-4012-2	
92	Washer, Flat, #4, SS	6-4000-13	
93	Washer, Flat, #8, SS	6-4000-5	
94	Washer, Lock, #8	6-4012-4	
95	Nut, Hex, 8-32	6-3000-4	
96	Washer, Flat, #6	6-4000-14	
98	Nut, Hex, 6-32	2-702	

Table B-8
Replaceable Parts List
PCB Assembly, DCR 20-1000A1
1058718-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
C9	Cap, 250 uF, 50V	24-2556-3
C10	Cap, 25 uF, 25V	235-7404P11
C11	Cap, 50 uF, 75V	235-7404P5
C12	Cap, 50 uF, 15V	235-7404P15
C13	Cap, 100 uF, 16V	235-7404P16
C15	Cap, 35 uF, 25V	235-7404P36
C16	Cap, .01 uF, 200V	24-2409-7
C17	Cap, 100 uF, 16V	235-7404P16
C18	Cap, 4 uF, 25V	235-7404P35
C19	Cap, 25 uF, 25V	235-7404P11
C20	Cap, .01 uF, 200V	24-2409-7
C21	Cap, .22 uF, 200V	24-2409-15
C22	Cap, .22 uF, 200V	24-2409-15
C23	Cap, .22 uF, 200V	24-2409-15
C24	Cap, 75 uF, 75V	24-2457-2
C25	Cap, 75 uF, 75V	24-2457-2
C26	Cap, 75 uF, 75V	24-2457-2
C27	Cap, 50 uF, 50V	235-7404P22
C42	Cap, 35 uF, 25V	235-7404P36
C44	Cap, .01 uF, 300V	235-7361P2
C45	Cap, 25 uF, 25V	235-7404P11
C47	Cap, .01 uF, 300V	235-7361P2
C48	Cap, .001 uF, 1500V	235-7207P16
CR11	Diode, S11	587565-1
CR17	Diode, S11	587565-1
CR18	Diode, RD5637	26-1017
CR19	Diode, RD5637	26-1017
CR20	Diode, Zener, 1N750A, 4.7V	26-211
CR22	Diode, S11	587565-1
CR23	Diode, S11	587565-1
CR24	Diode, Zener, 1N5226B, 5.6V	588101-3
CR25	Diode, RD5637	26-1017
CR26	Diode, RD5637	26-1017
CR28	Diode, Zener, 1N4747A, 20V	588102-13
CR29	Diode, Zener, 1N4747A, 20V	588102-13
CR30	Diode, Zener, 1N4747A, 20V	588102-13
CR31	Diode, S12	587565-2
CR32	Diode, S12	587565-2
CR33	Diode, S12	587565-2
CR34	Diode, S11	587565-1
CR35	Diode, S11	587565-1
CR36	Diode, S11	587565-1
K1	Relay	92-924
K2	Relay	92-924
Q1	Xstr, RT9338	18-146
Q2	Xstr, 40312	18-142
Q3	Xstr, PN3641	18-144

Table B-8 (Cont'd)
Replaceable Parts List
PCB Assembly, DCR 20-1000A1
1058718-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
Q4	Xstr, PN3641	18-144
Q5	Xstr, PN3641	18-144
Q6	Xstr, PN3641	18-144
Q7	Xstr, 2N3638	18-143
Q8	Xstr, 2N3638	18-143
Q9	Xstr, 2N3638	18-143
Q10	Xstr, 2N3638	18-143
Q11	Xstr, 2N3638	18-143
Q12	Xstr, 2N2926, Selected	386-7214P6
Q13	Xstr, 2N2926, Selected	386-7214P6
Q14	Xstr, PN3641	18-144
Q15	Xstr, 2N2219A	386-7249P32
Q16	Xstr, 2N3638	18-143
Q17	Xstr, 2N2647	18-153
Q18	Xstr, 2N3638	18-143
Q19	Xstr, 2N2647	18-153
Q20	Xstr, 2N3638	18-143
Q21	Xstr, 2N2647	18-153
R14	Res, 100, 1/2W	280-1145P38
R15	Res, 680, 2W	280-1147P68
R16	Res, 1.2K, 1/2W	280-1145P76
R17	Res, 1K, 1/2W	280-1145P74
R18	Res, 1K, 1/2W	280-1145P74
R19	Res, 1K, 1/2W	280-1145P74
R20	Res, Variable, 1K, 2W	29-406
R21	Res, 680, 1/2W	280-1145P68
R22	Res, 2.2K, 1/2W	280-1145P86
R23	Res, Variable, 500, 2W	29-450
R25	Res, Variable, 10K, 2W	29-493
R26	Res, 3.92K, 1/2W	28-1145
R27	Res, 221, 1/2W	28-1188
R29	Res, 1K, 1/2W	280-1147P74
R30	Res, 4.7K, 1/2W	280-1145P98
R31	Res, 681, 1/4W	28-1224
R32	Res, 332, 1/4W	28-1223
R33	Res, 10K, 1/4W	28-1226
R34	Res, 330, 1/2W	280-1145P56
R35	Res, 470, 1/2W	280-1145P62
R36	Res, 330, 1/2W	280-1145P56
R37	Res, 330, 1/2W	280-1145P56
R38	Res, 1K, 1/2W	280-1145P74
R39	Res, Variable, 2K, 2W	29-407
R40	Res, 475, 1/4W	28-1166
R43	Res, Variable, 4K, 2W	29-475
R44	Res, 470, 1/2W	280-1145P62
R45	Res, 4.7K, 1/2W	280-1145P98
R46	Res, 68K, 1/2W	280-1145P140

Table B-8 (Cont'd)
Replaceable Parts List
PCB Assembly, DCR 20-1000A1
1058718-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
R47	Res, 2.2K, 1/2W	280-1145P86
R48	Res, 6.8K, 1/2W	280-1145P104
R49	Res, 182, 1/4W	28-1222
R50	Res, 2.7K, 1/2W	280-1145P89
R51	Res, 2K, 5W	28-1200
R52	Res, 680, 1/2W	585326-107
R53	Res, 2K, 1/4W	28-1225
R54	Res, 121, 1/4W	28-1221
R56	Res, 220, 1W	280-1180P50
R57	Res, Variable, 50, 2W	29-467
R58	Res, 22, 1/2W	280-1145P14
R59	Res, 6.8K, 4W	167155-2
R60	Res, Variable, 2K, 2W	29-494
R61	Res, 390, 1/2W	280-1145P59
R62	Res, 6.8K, 4W	167155-2
R63	Res, Variable, 2K, 2W	29-494
R64	Res, 390, 1/2W	280-1145P59
R65	Res, 6.8K, 4W	167155-2
R66	Res, Variable, 2K, 2W	29-494
R67	Res, 390, 1/2W	280-1145P59
R68	Res, 3.3K, 3W	27-398-10
R69	Res, 3.3K, 3W	27-398-10
R70	Res, 3.3K, 3W	27-398-10
R72	Res, 220, 1/2W	280-1145P50
XK1	Socket, Relay	42-175
XK2	Socket, Relay	42-175

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Printed Circuit Board	79-106	
2	Heat Sink	73-1451	
3	Socket,	42-142	
69	Wire, 22 AWG	21-004	
71	PHMS, 4-40 X 3/8	6-1108	
72	Washer, Lock, #4	6-4012-2	
73	Nut, Hex, 4-40	6-1904	

Table B-9
Parts Location List
Top Cover Sub-Assembly, DCR 20-1000A1
1058644-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Cover	73-1444	
2	Plate, Capacitor Mounting	73-2411	
3	Bracket, Reinforcing	73-1446	
4	Buss Bar Cap. (-)	1058645-1	
5	Buss Bar	73-2462	
7	Buss Bar	1058646-1	
9	Eyebolt	1-9146	
10	Clamp, Cap., DC	70-8406	
11	Cap, 115,000 uF, 25V	24-2549	C7A
	Cap, 115,000 uF, 25V	24-2549	C7B
	Cap, 115,000 uF, 25V	24-2549	C7B
	Cap, 115,000 uF, 25V	24-2549	C7D
	Cap, 115,000 uF, 25V	24-2549	C7E
	Cap, 115,000 uF, 25V	24-2549	C7F
	Cap, 115,000 uF, 25V	24-2549	C7G
	Cap, 115,000 uF, 25V	24-2549	C7H
	Cap, 115,000 uF, 25V	24-2549	C7J
	Cap, 115,000 uF, 25V	24-2549	C7K
	Cap, 115,000 uF, 25V	24-2549	C7L
	Cap, 115,000 uF, 25V	24-2549	C7M
	Cap, 115,000 uF, 25V	24-2549	C7N
	Cap, 115,000 uF, 25V	24-2549	C7P
	Cap, 115,000 uF, 25V	24-2549	C7R
	Cap, 115,000 uF, 25V	24-2549	C7S
	Cap, 115,000 uF, 25V	24-2549	C7T
	Cap, 115,000 uF, 25V	24-2549	C7U
12	Buss Bar	73-2464	
16	PHMS, 6-32 X 7/8	6-2001-16	
17	PHMS, 8-32 X 1/2	6-2001-24	
18	FHMS, 10-32 X 7/16, 100°	6-2020-50	
24	Washer, Lock, 1/2	6-4013-12	
27	Nut, Hex, 6-32	2-137	
28	Nut, Hex, 8-32	2-361	
30	Nut, Hex, 1/2-13	6-3001-12	
31	Washer, Lock, #10	6-4012-5	
32	PHMS, 10-32 X 1/2	6-2000-44	
33	HHMS, 1/4-20 X 5/8	1058421-17	
34	Fastener, Nut, Locking	1058472-1	

Table B-10
Replaceable Parts List
Front Panel Sub-Assembly, DCR 20-1000A1
190-3877-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
CR27	Diode, Zener, 1N5234B	588101-9
DS1	Lamp, #1829, 28V	277-1001P11
DS2	Lamp, #1302, 6.3V	42-341
DS3	Lamp, NE51	42-301
DS4	Lamp, #1302, 6.3V	42-341
R24	Res, Variable, 150, 2W	29-391
R41	Res, Variable, 3K, 2W	29-408
R42	Res, Variable, 150, 2W	29-391
R55	Res, 5.1K, 2W	280-1147P99
R71	Res, 150, 1W	280-1180P44
XDS1	Pilot Lamp Holder	43-322
XDS2	Pilot Lamp Holder	43-341
XDS3	Lamp Holder	42-383
XDS4	Pilot Lamp Holder	43-322

Table B-11
Parts Location List
Front Panel Sub-Assembly, DCR 20-1000A1
190-3877-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Panel, Front, DCR 20-1000	73-2595	
9	Res, Variable, 150, 2W	29-391	R24
	Res, Variable, 150, 2W	29-391	R42
10	Res, Variable, 3K, 2W	29-408	R41
12	Pilot Lamp Holder	43-322	XDS1
	Pilot Lamp Holder	43-322	XDS4
13	Lamp Holder	42-383	XDS3
14	Pilot Lamp Holder	43-341	XDS2
15	Lamp, #1829, 28V	277-1001P11	DS1
16	Lamp, NE51	42-301	DS3
17	Lamp, #1302, 6.3V	42-341	DS2
	Lamp, #1302, 6.3V	42-341	DS4
18	Diode, Zener, 1N5234B	588101-9	CR27
19	Res, 5.1K, 2W	280-1147P99	R55
20	Voltmeter, 25V	94-579-2	M2
21	Ammeter, 1200A	94-462-23	M1
22	Res, 150, 1W	280-1180P44	R71
23	Clamp, Cable	93-401	
24	Clamp	93-243	
25	Knob	42-277	
27	Nut, Hex, 3/8-32	2-366	
28	Nut, Hex, 6-32	2-360	
30	FHMS, 6-32 X 1/2	6-2020-21	
31	Nameplate	1058468-1	
32	Harness, AC, Front Panel	1058653-1	

Table B-12
Replaceable Parts List
Circuit Breaker Sub-Assembly, DCR 20-1000A1
1058647-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
C39	Cap, 2 uF, 660 Vac	1058531-1
C40	Cap, 2 uF, 660 Vac	1058531-1
C41	Cap, 2 uF, 660 Vac	1058531-1
CB1	Circuit Breaker	92-349
E41	Lug, Solder	4-136
E42	Lug, Solder	4-136
E43	Lug, Solder	4-136
T5	Transformer, Fan	1058665-1
TB15	Terminal Block	247-7201P1

Table B-13
Parts Location List
Circuit Breaker Sub-Assembly, DCR 20-1000A1
1058647-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Bracket, Circuit Breaker	1058643-1	
2	PHMS, 6-32 X 7/8	6-2001-16	
3	Circuit Breaker	92-349	CB1
4	Washer, Lock, #6	6-4012-3	
5	Cap, 2 uF, 660 Vac	1058531-1	C39
	Cap, 2 uF, 660 Vac	1058531-1	C40
	Cap, 2 uF, 660 Vac	1058531-1	C41
6	Grommet	359-7205P2	
7	Tie-Wrap	362-7195P7	
8	Washer, Flat, #8	6-4000-5	
12	PHMS, 8-32 X 5/8	6-2001-25	
13	Nut, Hex, 8-32	2-361	
14	Transformer, Fan	1058665-1	T5
15	Washer, Flat, #6	6-4000-14	
16	Washer, Lock, #8	6-4012-4	
17	Terminal Block	247-7201P1	TB15
18	Lug, Solder	4-136	E41
	Lug, Solder	4-136	E42
	Lug, Solder	4-136	E43
19	Tie-Wrap	362-7195P1	

Table B-14
Replaceable Parts List
Bottom Chassis Sub-Assembly, DCR 20-1000A1
1058660-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
L1	Choke, RFI	127-1761
L2	Choke, RFI	127-1761
L3	Choke, RFI	127-1761
L4	Choke, Filter	127-1809
T1	Transformer, Rectifier, Input	126-3039
T2	Transformer, Rectifier, Input	126-3039
T3	Transformer, Rectifier, Input	126-3039

Table B-15
Parts Location List
Bottom Chassis Sub-Assembly, DCR 20-1000A1
1058660-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Chassis	170-1104	
2	Spacer	73-1385	
3	Caster, Rigid	91-1377	
4	Caster, Swivel	91-1376	
6	Transformer, Rectifier, Input	126-3039	T1
	Transformer, Rectifier, Input	126-3039	T2
	Transformer, Rectifier, Input	126-3039	T3
7	Choke, RFI	127-1761	L1
	Choke, RFI	127-1761	L2
	Choke, RFI	127-1761	L3
9	Buss Bar	1058649-1	
10	Buss Bar Conn.	1058650-1	
11	Buss Bar	1058651-1	
12	Buss Bar	1058652-1	
13	PHTF, 8-32 X 1/2	6-2004-28	
14	HHMS, 3/8-16 X 1	6-107	
15	Washer, Flat, 3/8	6-4001-10	
16	HHMS, 5/16-18 X 5/8	1058421-37	
17	Fastener, Nut, Locking	1058472-1	
18	Washer, Lock, 3/8	6-4013-10	
19	HHMS, 1/4-20 X 5/8	1058421-17	
20	Clamp, Cable	93-245	
21	Clamp	93-247	
22	Input Power Cable	1058711-1	
23	Cable, Primary	1058663-1	
24	L-Nut, 1/4-20	2-364	
25	Washer, Flat, 1/4	6-4000-8	
26	Nut, Hex, 5/16-18	1058472-2	

APPENDIX C

DCR 40-500A1

C.1 GENERAL

The DCR 40-500A1 is an updated version of the DCR 40-500A. Some items used in the manufacture of the DCR 40-500A have become unavailable. The engineers at Sorensen have taken this opportunity to improve airflow conditions and to utilize upgraded components in the high current rectifiers.

The specifications remain the same but with increased cooling to provide improved performance and longer life. This Appendix will describe the DCR 40-500A1 through schematic diagrams, assembly drawings, and parts lists to reflect the changes that have occurred in the design.

All operation and maintenance information for this unit may be found in the standard DCR-A instruction manual, Sorensen document number 1057663.

Table C-1
Parts Location List
Final Assembly, DCR 40-500A1
1058668-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Bottom Chassis Assembly	1058671-1	
2	Rectifier Assembly	1058720-1	
3	Rear Panel Sub-Assembly	1058675-1	
4	Top Cover Sub-Assembly	1058677-1	
5	Front Panel Assembly	1058684-1	
6	Circuit Breaker Sub-Assembly	1058672-1	
7	Fastener, Nut, Locking	1058472-1	
8	HHMS, 1/4-20 X 5/8	1058421-17	
10	Panel, Rear Left	73-1592	
11	Bracket, Output Cable	1058661-1	
12	Panel, Rear Bottom	73-2365	
13	Panel, Front Bottom	1058692-1	
14	Panel, Right Side	1058619-1	
15	Left Panel Fan Assembly	1058669-1	
16	Plate, Access	73-2378	
17	Buss Bar, Neg to HS	1058683-1	
18	Decal, Nameplate	73-2013	
20	Bushing, Male	43-1091	
28	Clamp	93-247	
29	Jumper Kit (Lead)	1058674-1	
31	Decal	73-2064	
32	HHMS, 1/4-20 X 1	1058421-2	
33	HHMS, 3/8-16 X 1	6-107	
34	PHMS, 6-32 X 5/16	6-2002-24	
35	HHMS, 5/16-18 X 5/8	1058421-37	
36	Nut, Hex, 5/16-18	1058472-2	
37	PHMS, 10-32 X 1/2	6-2000-44	
38	PHMS, 8-32 X 1/2	6-2000-34	
39	FHMS, 10-32 X 1/2	6-2020-51	
43	Washer, Flat, 3/8	6-4001-10	
47	Nut, Hex, 10-32	2-362	
49	Nut, Hex, 3/8-16	6-3001-10	
50	Washer, Lock, 3/8	6-4013-10	
51	Connector, Electrical, Cover	1057763-1	

Table C-2
Parts Location List
Rectifier Assembly, DCR 40-500A1
1058720-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Diode, PDA 6BFR7MRV20	1058581-1	
2	Buss Bar, Neg Out	1058621-1	
3	Buss Bar	1058622-1	
4	Buss Bar To Lead	1058623-1	E50
	Buss Bar To Lead	1058623-1	E51
5	Insulator Bar	1058624-1	
6	Heatsink Bracket Assembly	1058719-1	
7	Buss Bar	1058627-1	
8	Buss Bar, T1 Output	1058628-1	
9	Bracket, Left	1058629-1	
10	Bracket, Right	1058629-2	
11	Thermo, 240V, 2400W	1058402-2	S1
	Thermo, 240V, 2400W	1058402-2	S2
	Thermo, 240V, 2400W	1058402-2	S5
12	HHMS, 5/16-18 X 1	6-2010-24	
13	Washer, Flat, 5/16	6-4001-9	
14	Nut, Hex, 5/16-18	1058472-2	
15	Screw, Modified	1058666-1	
16	L Spacer	30-060-139	
17	PHMS, 10-32 X 7/8	6-2002-58	
18	Washer, Lock, #10	6-4012-5	
19	Washer, Flat, #10	6-4000-6	
20	Nut, Hex, 10-32	2-362	
21	HHMS, 5/16-18 X 1	1058421-8	
24	Clamp, Cable	168733-1	
26	Retainer, Nylon	362-7195P2	
27	PHMS, 10-32 X 1/2	6-2001-34	

Table C-3
Replaceable Parts List
Heat Sink Bracket Assembly, DCR 40-500A1
1058719-1

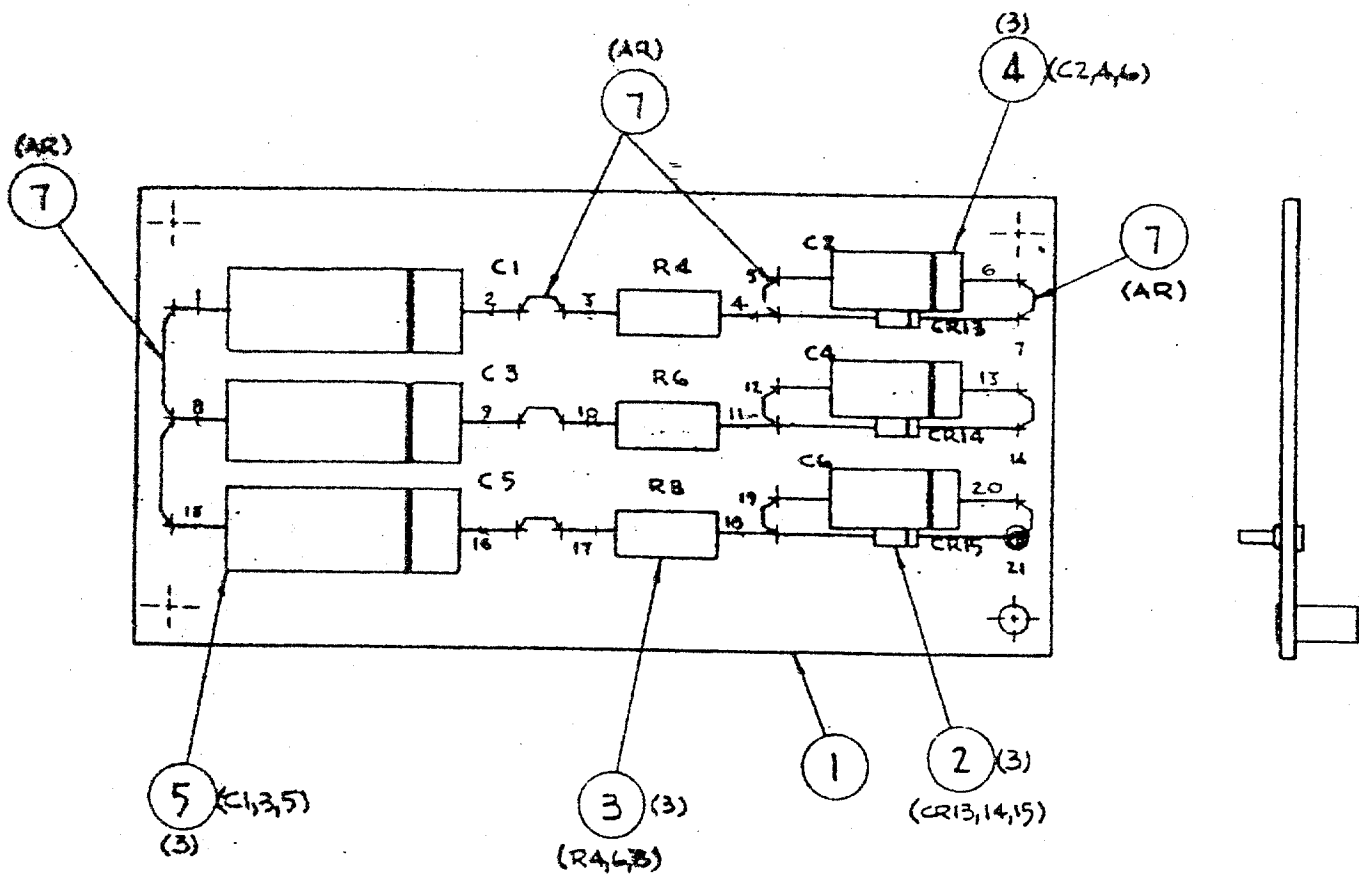
<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
CR1	Diode, C145P	26-1031
CR2	Diode, 1N3768	588853-1
CR3	Diode, C145P	26-1031
CR4	Diode, 1N3768	588853-1
CR5	Diode, C145P	26-1031
CR6	Diode, 1N3768	588853-1
S3	Thermostat	92-510
S4	Thermostat	91-1286
TB4	Terminal Board	40-3749
TB17	Terminal Block, 2, 30A	247-7204P2

Table C-4
Parts Location List
Heat Sink Bracket Assembly, DCR 40-500A1
1058719-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Bracket, Heat Sink	1058626-1	
2	Terminal Board	40-3749	TB4
3	Bracket, Heat Sink	73-2478	
4	Heat Sink	91-1805	
5	Heat Sink, Extruded Aluminum	91-1807-1	
6	Component Board Assembly	190-3868	
7	Diode, 1N3768	588853-1	CR2
	Diode, 1N3768	588853-1	CR4
	Diode, 1N3768	588853-1	CR6
8	Diode, C145P	26-1031	CR1
	Diode, C145P	26-1031	CR3
	Diode, C145P	26-1031	CR5
9	Thermostat	91-1286	S4
10	Thermostat	92-510	S3
11	Lug, #6	4-114	
12	Washer, Flat, #2	6-4000-2	
13	PHMS, 2-56 X 1/4	6-2001-56	
14	PHMS, 4-40 X 3/8	6-2001-58	
15	PHMS, 6-32 X 3/8	6-2001-13	
16	PHMS, 6-32 X 1/2	6-2001-14	
17	PHMS, 8-32 X 7/8	6-2001-83	
18	PHMS, 10-32 X 1	6-2001-37	
19	HHMS, 1/4-20 X 1/2	6-2010-13	
20	Washer, Flat, #6	6-4000-4	
21	Washer, Flat, #8	6-4000-5	
22	Washer, Flat, #10	6-4000-6	
23	Washer, Lock, Split, 1/4	6-4013-8	
24	Washer, Lock, #2	6-4012-1	

Table C-4 (Cont'd)
 Parts Location List
 Heat Sink Bracket Assembly, DCR 40-500A1
 1058719-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
25	Washer, Lock, #6	6-4012-3	
26	Nut, Hex, 2-56, SS	6-3000-1	
28	Nut, Hex, 6-32	2-360	
29	Nut, Hex, 8-32	2-361	
30	Nut, Hex, 10-32	2-362	
31	Washer, Lock, #8	6-4012-4	
36	Terminal Block, 2, 30A	247-7204P2	



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Figure C-5 Component Board Assembly, DCR 40-500A1, Assembly Drawing

Table C-5
 Replaceable Parts List
 Component Board Assembly, DCR 40-500A1
 190-3868

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
C1	Cap, .68 uF, 1000V	24-2111-12
C2	Cap, .1 uF, 200V	24-2409-13
C3	Cap, .68 uF, 1000V	24-2111-12
C4	Cap, .1 uF, 200V	24-2409-13
C5	Cap, .68 uF, 1000V	24-2111-12
C6	Cap, .1 uF, 200V	24-2409-13
CR13	Diode, RD5637	26-1017
CR14	Diode, RD5637	26-1017
CR15	Diode, RD5637	26-1017
R4	Res, 33, 2W	280-1147P20
R6	Res, 33, 2W	280-1147P20
R8	Res, 33, 2W	280-1147P20

Table C-6
Replaceable Parts List
Rear Panel Sub-Assembly, DCR 40-500A1
1058675-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
C8	Cap, .22 uF, 200V	24-2409-15
C28	Cap, .22 uF, 1 kV	983970-1
C29	Cap, .22 uF, 1 kV	983970-1
C30	Cap, .22 uF, 1 kV	983970-1
C37	Cap, 2.0 uF, 200V	24-2409-21
C38	Cap, 2.0 uF, 200V	24-2409-21
E6	Lug, Solder	4-142
E9	Lug, Solder	4-129
E10	Lug	4-141
E11	Lug	4-141
E13	Lug, Solder	4-142
R1A	Res, 0.16, 175W	27-1071
R1B	Res, 0.16, 175W	27-1071
R1C	Res, 0.16, 175W	27-1071
R1D	Res, 0.16, 175W	27-1071
R2A	Res, 0.16, 175W	27-1071
R2B	Res, 0.16, 175W	27-1071
R2C	Res, 0.16, 175W	27-1071
R2D	Res, 0.16, 175W	27-1071
R3A	Res, 0.16, 175W	27-1071
R3B	Res, 0.16, 175W	27-1071
R3C	Res, 0.16, 175W	27-1071
R3D	Res, 0.16, 175W	27-1071
R12	Shunt, 600A, 50 mV	94-014
R13A	Res, 0.0013	589198-1
R13B	Res, 0.0013	589198-1
T4	Transformer	126-2856
T6	Transformer, Pulse	126-2632
T7	Transformer, Pulse	126-2632
T8	Transformer, Pulse	126-2632
TB1	Terminal Board	42-090
TB2	Terminal Strip	43-082-1
TP1	Terminal Strip, Standard	587878-6

Table C-7
Parts Location List
Rear Panel Sub-Assembly, DCR 40-500A1
1058675-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Panel, Rear	1058631-1	
2	Barrier	73-1587	
3	Bracket, Terminal Board	1058632-1	
4	Insulator, Phenolic	1058634-1	

Table C-7 (Cont'd)
Parts Location List
Rear Panel Sub-Assembly, DCR 40-500A1
1058675-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
6	Shunt Terminal Board	1058659-1	
7	Support, L-Bracket	1058689-1	
8	Buss Bar	1058636-1	
9	Buss Bar (Jumper)	1058637-1	
10	Buss Bar	1058676-1	
11	Buss Bar Pos Out	1058639-1	
12	Buss Bar Neg Out	1058640-1	
13	Bracket, Shunt Mounting	73-1584	
14	Buss Bar Pos. Output	1059331-1	
15	Buss Bar Conn. Choke	1058642-1	
16	Harness, Rear Panel	1058682-1	
17	Main Harness	1058680-2	
18	Jumper Kit	1058681-1	
19	Shunt, 600A, 50 mV	94-014	
20	Res, 0.0013	589198-1	R13A
	Res, 0.0013	589198-1	R13B
21	PCB Assembly	1058678-1	A1
22	Transformer, Pulse	126-2632	T6
	Transformer, Pulse	126-2632	T7
	Transformer, Pulse	126-2632	T8
23	Transformer	126-2856	T4
24	Res, 0.16, 175W	27-1071	R1A
	Res, 0.16, 175W	27-1071	R1B
	Res, 0.16, 175W	27-1071	R1C
	Res, 0.16, 175W	27-1071	R1D
	Res, 0.16, 175W	27-1071	R2A
	Res, 0.16, 175W	27-1071	R2B
	Res, 0.16, 175W	27-1071	R2C
	Res, 0.16, 175W	27-1071	R2D
	Res, 0.16, 175W	27-1071	R3A
	Res, 0.16, 175W	27-1071	R3B
	Res, 0.16, 175W	27-1071	R3C
	Res, 0.16, 175W	27-1071	R3D
26	Cap, 2.0 uF, 200V	24-2409-21	C37
	Cap, 2.0 uF, 200V	24-2409-21	C38
27	Cap, .22 uF, 200V	24-2409-15	C8
28	Cap, .22 uF, 1 kV	983970-1	C28
	Cap, .22 uF, 1 kV	983970-1	C29
	Cap, .22 uF, 1 kV	983970-1	C30
29	Lug, #4	4-113	
31	Terminal Board	4-090	TB1
32	Terminal Strip	43-082-1	TB2
33	Lug, Solder	4-129	E9
34	Lug, Solder	4-142	E6

Table C-7 (Cont'd)
Parts Location List
Rear Panel Sub-Assembly, DCR 40-500A1
1058675-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
35	Lug, Solder	4-142	E13
	Lug	4-141	E10
	Lug	4-141	E11
36	Clamp	93-244	
37	Clamp, Cable	93-401	
38	Bumper, Rubber	359-7195P7	
39	Grommet	359-7176P18	
40	Grommet	359-7205P2	
41	Washer, Mica	3-368	
42	Washer, Centering	3-448	
44	PHMS, 10-32 X 1	6-2001-37	
45	PHTF, 6-32 X 3/8	6-2004-21	
47	PHMS, 6-32 X 5/8	6-2001-15	
48	HHMS, 1/2-13 X 2 1/2	6-132	
50	PHMS, 10-32 X 1/2	6-2001-34	
53	Thru-Bolt, 10-32 X 6 3/4	1-9077	
54	PHMS, 1/4-28 X 2	1-9357	
55	PHMS, 1/4-20 X 1	6-2001-47	
56	HHMS, 3/8-16 X 1	6-107	
57	HHMS, 3/8-16 X 2 1/2	6-1136	
58	Cap, Screw, Hex Head	6-1149	
59	Strap Mount	93-511	
60	Clamp	362-7195P3	
61	Washer, Flat, #6	6-4000-4	
62	Washer, Flat, #10	6-4000-6	
63	Washer, Split, 1/4	6-4001-8	
64	Washer, Flat, 3/8	6-4001-10	
65	Washer, Flat, 1/2	6-4001-12	
66	Nut, Hex, 6-32	2-360	
68	Nut, Hex, 10-32	2-362	
69	HHMS, 1/2-13 X 2	6-131	
70	Nut, Hex, 1/4-28	2-045	
71	L-Nut, 1/4-20	2-364	
72	Nut, Hex, 3/8-16	6-3001-10	
73	Nut, Hex, 1/2-13	6-3001-12	
74	Nut, Jam, 3/8-16	6-1912	
75	HHMS, 1/4-20 X 1	1058421-2	
76	Washer, Lock, Int. Tooth, 1/4	6-4011-8	
77	Washer, Lock, #6	6-4012-3	
78	Fastener, Nut, Locking	1058472-1	
79	Washer, Lock, Split, 1/4	6-4013-8	
80	Washer, Lock, 3/8	6-4013-10	
81	Washer, Lock, 1/2	6-4013-12	
84	Terminal Strip, Standard	587878-6	TP1
85	PHMS, 4-40 X 5/16	6-2001-66	
86	Nut, Locking, 4-40	2-649	
89	Washer, Lock, #10	6-4012-5	

Table C-7 (Cont'd)
Parts Location List
Rear Panel Sub-Assembly, DCR 40-500A1
1058675-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
90	PHMS, 4-40 X 3/8, SS	207-7195P167	
91	Washer, Lock, #4	6-4012-2	
92	Washer, Flat, #4, SS	6-4000-13	
93	Washer, Flat, #8, SS	6-4000-5	
94	Washer, Lock, #8	6-4012-4	
95	Nut, Hex, 8-32	6-3000-4	
96	Washer, Flat, #6	6-4000-14	
98	Nut, Hex, 6-32	2-702	
99	Connector, Electric, Cover	1057763-14	

Table C-8
Replaceable Parts List
PCB Assembly, DCR 40-500A1
1058678-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
C9	Cap, 250 uF, 50V	24-2556-3
C10	Cap, 25 uF, 25V	235-7404P11
C11	Cap, 100 uF, 25V	235-7404P8
C12	Cap, 20 uF, 16V	235-7404P33
C13	Cap, 100 uF, 16V	235-7404P16
C15	Cap, 35 uF, 25V	235-7404P36
C16	Cap, .01 uF, 200V	24-2409-7
C17	Cap, 100 uF, 16V	235-7404P16
C18	Cap, 4 uF, 50V	235-7404P38
C19	Cap, 25 uF, 25V	235-7404P11
C20	Cap, .01 uF, 200V	24-2409-7
C21	Cap, .22 uF, 200V	24-2409-15
C22	Cap, .22 uF, 200V	24-2409-15
C23	Cap, .22 uF, 200V	24-2409-15
C24	Cap, 75 uF, 75V	24-2457-2
C25	Cap, 75 uF, 75V	24-2457-2
C26	Cap, 75 uF, 75V	24-2457-2
C27	Cap, 50 uF, 50V	235-7404P22
C42	Cap, 35 uF, 25V	235-7404P36
C43	Cap, .001 uF, 1500V	235-7207P16
CR16	Diode, 1N5614	587565-1
CR17	Diode, 1N5614	587565-1
CR18	Diode, RD5637	26-1017
CR19	Diode, RD5637	26-1017
CR20	Diode, Zener, 1N750A, 4.7V	26-211
CR22	Diode, 1N5614	587565-1
CR23	Diode, 1N5614	587565-1
CR24	Diode, Zener, 1N5226B, 5.6V	588101-3
CR25	Diode, RD5637	26-1017
CR26	Diode, RD5637	26-1017
CR28	Diode, Zener, 1N4747A, 20V	588102-13
CR29	Diode, Zener, 1N4747A, 20V	588102-13
CR30	Diode, Zener, 1N4747A, 20V	588102-13
CR31	Diode, 1N5614	587565-2
CR32	Diode, 1N5614	587565-2
CR33	Diode, 1N5614	587565-2
CR34	Diode, 1N5614	587565-1
CR35	Diode, 1N5614	587565-1
CR36	Diode, 1N5614	587565-1
K1	Relay	92-924
K2	Relay	92-924
Q1	Xstr, RT9338	18-146
Q2	Xstr, 40312	18-142
Q3	Xstr, PN3641	18-144

Table C-8 (Cont'd)
Replaceable Parts List
PCB Assembly, DCR 40-500A1
1058678-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
Q4	Xstr, PN3641	18-144
Q5	Xstr, PN3641	18-144
Q6	Xstr, PN3641	18-144
Q7	Xstr, 2N3638	18-143
Q8	Xstr, 2N3638	18-143
Q9	Xstr, 2N3638	18-143
Q10	Xstr, 2N3638	18-143
Q11	Xstr, 2N3638	18-143
Q12	Xstr, 2N2926, Selected	386-7214P6
Q13	Xstr, 2N2926, Selected	386-7214P6
Q14	Xstr, PN3641	18-144
Q15	Xstr, 2N2219A	386-7249P32
Q16	Xstr, 2N3638	18-143
Q17	Xstr, 2N2647	18-153
Q18	Xstr, 2N3638	18-143
Q19	Xstr, 2N2647	18-153
Q20	Xstr, 2N3638	18-143
Q21	Xstr, 2N2647	18-153
R14	Res, 100, 1/2W	280-1145P38
R15	Res, 680, 2W	280-1147P68
R16	Res, 1.2K, 1/2W	280-1145P76
R17	Res, 1K, 1/2W	280-1145P74
R18	Res, 1K, 1/2W	280-1145P74
R19	Res, 1K, 1/2W	280-1145P74
R20	Res, Variable, 1K, 2W	29-406
R21	Res, 680, 1/2W	280-1145P68
R22	Res, 2.2K, 1/2W	280-1145P86
R23	Res, Variable, 500, 2W	29-450
R25	Res, Variable, 10K, 2W	29-493
R26	Res, 3.92K, 1/2W	28-1145
R27	Res, 221, 1/2W	28-1188
R28	Res, 100, 1/2W	280-1145P38
R29	Res, 1K, 1/2W	280-1147P74
R30	Res, 4.7K, 1/2W	280-1145P98
R31	Res, 681, 1/4W	28-1224
R32	Res, 332, 1/4W	28-1223
R33	Res, 10K, 1/4W	28-1226
R34	Res, 330, 1/2W	280-1145P56
R35	Res, 470, 1/2W	280-1145P62
R36	Res, 330, 1/2W	280-1145P56
R37	Res, 330, 1/2W	280-1145P56
R38	Res, 1K, 1/2W	280-1145P74
R39	Res, Variable, 2K, 2W	29-407
R40	Res, 475, 1/4W	28-1166
R43	Res, Variable, 2K, 2W	29-407
R44	Res, 470, 1/2W	280-1145P62
R45	Res, 4.7K, 1/2W	280-1145P98
R46	Res, 68K, 1/2W	280-1145P140

Table C-8 (Cont'd)
Replaceable Parts List
PCB Assembly, DCR 40-500A1
1058678-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
R47	Res, 2.2K, 1/2W	280-1145P86
R48	Res, 6.8K, 1/2W	280-1145P104
R49	Res, 182, 1/4W	28-1222
R50	Res, 2.7K, 1/2W	280-1145P89
R51	Res, 4.7K, 5W	28-1150
R52	Res, 900, 3W	28-1153
R53	Res, 2K, 1/4W	28-1225
R54	Res, 121, 1/4W	28-1221
R56	Res, 220, 1W	280-1180P50
R57	Res, Variable, 50, 2W	29-467
R58	Res, 22, 1/2W	280-1145P14
R59	Res, 6.8K, 4W	167155-2
R60	Res, Variable, 2K, 2W	29-494
R61	Res, 390, 1/2W	280-1145P59
R62	Res, 6.8K, 4W	167155-2
R63	Res, Variable, 2K, 2W	29-494
R64	Res, 390, 1/2W	280-1145P59
R65	Res, 6.8K, 4W	167155-2
R66	Res, Variable, 2K, 2W	29-494
R67	Res, 390, 1/2W	280-1145P59
R68	Res, 3.3K, 3W	27-398-10
R69	Res, 3.3K, 3W	27-398-10
R70	Res, 3.3K, 3W	27-398-10
XK1	Socket, Relay	42-175
XK2	Socket, Relay	42-175

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Printed Circuit Board	79-056	
2	socket	42-142-1	
65	Heat Sink	73-1451	
66	PHMS, 4-40 X 3/8	6-1108	
67	Washer, Lock, #4	6-4012-2	
68	Nut, Hex, 4-40	6-1904	
69	Wire, 22 AWG	21-004	
70	Cable From PCB	1058679-1	
71	Cable 2 From PCB J3	1058686-1	
72	Cable 3 From PCB J4	1058687-1	
73	Connector, Electrical, Cover	1057763-14	

Table C-9
Parts Location List
Top Cover Sub-Assembly, DCR 40-500A1
1058677-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Cover	73-1444	
2	Plate, Capacitor Mounting	73-2411	
3	Bracket, Reinforcing	73-1446	
4	Buss Bar Cap. (-)	1058645-1	
5	Buss Bar	73-2462	
7	Buss Bar	1058646-1	
9	Eyebolt	1-9146	
10	Clamp, Cap., DC	70-8406	
11	Cap, 56,000 uF, 50V	24-2548	C7A
	Cap, 56,000 uF, 50V	24-2548	C7B
	Cap, 56,000 uF, 50V	24-2548	C7B
	Cap, 56,000 uF, 50V	24-2548	C7D
	Cap, 56,000 uF, 50V	24-2548	C7E
	Cap, 56,000 uF, 50V	24-2548	C7F
	Cap, 56,000 uF, 50V	24-2548	C7G
	Cap, 56,000 uF, 50V	24-2548	C7H
	Cap, 56,000 uF, 50V	24-2548	C7J
	Cap, 56,000 uF, 50V	24-2548	C7K
	Cap, 56,000 uF, 50V	24-2548	C7L
	Cap, 56,000 uF, 50V	24-2548	C7M
12	Buss Bar	73-2464	
16	PHMS, 6-32 X 7/8	6-2001-16	
17	PHMS, 8-32 X 1/2	6-2001-24	
18	FHMS, 10-32 X 7/16, 100°	6-2020-50	
24	Washer, Lock, 1/2	6-4013-12	
27	Nut, Hex, 6-32	2-137	
28	Nut, Hex, 8-32	2-361	
30	Nut, Hex, 1/2-13	6-3001-12	
31	Washer, Lock, #10	6-4012-5	
32	PHMS, 10-32 X 1/2	6-2000-44	
33	HHMS, 1/4-20 X 5/8	1058421-17	
34	Fastener, Nut, Locking	1058472-1	

Table C-10
Replaceable Parts List
Front Panel Assembly, DCR 40-500A1
1058684-2

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
CR27	Diode, Zener, 1N5234B	588101-9
DS1	Lamp, #1829, 28V	277-1001P11
DS2	Lamp, #1302, 6.3V	42-341
DS3	Lamp, NE51	42-301
DS4	Lamp, #1302, 6.3V	42-341
M1	Ammeter, 600A	94-462-22
M2	Voltmeter, 50V	94-579-3
R24	Res, Variable, 150, 2W	29-391
R41	Res, Variable, 3K, 2W	29-408
R42	Res, Variable, 150, 2W	29-391
R55	Res, 5.1K, 2W	280-1147P99
R71	Res, 150, 1W	280-1180P44
XDS1	Pilot Lamp Holder	43-322
XDS2	Pilot Lamp Holder	43-341
XDS3	Lamp Holder	42-383
XDS4	Pilot Lamp Holder	43-322

Table C-11
Parts Location List
Front Panel Assembly, DCR 40-500A1
1058684

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Panel, Front, DCR 40-500A1	1058691-1	
9	Res, Variable, 150, 2W	29-391	R24
	Res, Variable, 150, 2W	29-391	R42
10	Res, Variable, 3K, 2W	29-408	R41
12	Pilot Lamp Holder	43-322	XDS1
	Pilot Lamp Holder	43-322	XDS4
13	Lamp Holder	42-383	XDS3
14	Pilot Lamp Holder	43-341	XDS2
15	Lamp, #1829, 28V	277-1001P11	DS1
16	Lamp, NE51	42-301	DS3
17	Lamp, #1302, 6.3V	42-341	DS2
	Lamp, #1302, 6.3V	42-341	DS4
18	Diode, Zener, 1N5234B	588101-9	CR27
19	Res, 5.1K, 2W	280-1147P99	R55
20	Voltmeter, 50V	94-579-3	M2
21	Ammeter, 600A	94-462-22	M1
22	Res, 150, 1W	280-1180P44	R71
23	Clamp, Cable	93-401	
25	Knob	42-277	
27	Nut, Hex, 3/8-32	2-366	
28	Clamp, Stick-on	168733-1	
31	Nameplate	1058468-1	
32	Harness, AC, Front Panel	1058653-1	

Table C-12
Replaceable Parts List
Circuit Breaker Sub-Assembly, DCR 40-500A1
1058672-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
C39	Cap, 2 uF, 660 Vac	1058531-1
C40	Cap, 2 uF, 660 Vac	1058531-1
C41	Cap, 2 uF, 660 Vac	1058531-1
CB1	Circuit Breaker	92-349
E41	Lug, Solder	4-136
E42	Lug, Solder	4-136
E43	Lug, Solder	4-136

Table C-13
Parts Location List
Circuit Breaker Sub-Assembly, DCR 40-500A1
1058672-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Bracket, Circuit Breaker	1058673-1	
3	Circuit Breaker	92-349	CB1
4	Washer, Lock, #6	6-4012-3	
5	Cap, 2 uF, 660 Vac	1058531-1	C39
	Cap, 2 uF, 660 Vac	1058531-1	C40
	Cap, 2 uF, 660 Vac	1058531-1	C41
6	Grommet	359-7205P2	
7	Tie-Wrap	362-7195P7	
8	Washer, Flat, #8	6-4000-5	
12	PHMS, 8-32 X 5/8	6-2001-25	
16	Washer, Lock, #8	6-4012-4	
18	Lug, Solder	4-136	E41
	Lug, Solder	4-136	E42
	Lug, Solder	4-136	E43

Table C-14
Replaceable Parts List
Bottom Chassis Sub-Assembly, DCR 40-500A1
1058671-1

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
L1	Choke, RFI	127-1761
L2	Choke, RFI	127-1761
L3	Choke, RFI	127-1761
L4	Choke, DC	982290-1
T1	Transformer, Rectifier, Input	126-3119
T2	Transformer, Rectifier, Input	126-3119
T3	Transformer, Rectifier, Input	126-3119

Table C-15
Parts Location List
Bottom Chassis Sub-Assembly, DCR 40-500A1
1058671-1

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Chassis	170-1104	
2	Spacer	73-1385	
3	Caster, Rigid	91-1377	
4	Caster, Swivel	91-1376	
5	Cable, Choke	191-824	
6	Transformer, Rectifier, Input	126-3119	T1
	Transformer, Rectifier, Input	126-3119	T2
	Transformer, Rectifier, Input	126-3119	T3
7	Choke, DC	982290-1	L4
8	Choke, RFI	127-1761	L1
	Choke, RFI	127-1761	L2
	Choke, RFI	127-1761	L3
9	Buss Bar	73-3190	
10	Buss Bar Conn.	1058650-1	
11	Angle, Buss	73-3191	
12	Buss Bar	1058652-1	
13	PHTF, 8-32 X 1/2	6-2004-28	
14	HHMS, 3/8-16 X 1	6-107	
15	Washer, Flat, 3/8	6-4001-10	
16	HHMS, 5/16-18 X 1	1058421-8	
17	Fastener, Nut, Locking	1058472-1	
18	Washer, Lock, 3/8	6-4013-10	
19	HHMS, 1/4-20 X 5/8	1058421-17	
20	Clamp, Cable	93-245	
21	Clamp	93-247	
22	Cable, Input Power	1058711-1	
23	Cable, Primary	1058663-1	
24	L-Nut, 1/4-20	2-364	
25	Washer, Flat, 1/4	6-4000-8	
26	Nut, Hex, 5/16-18	1058472-2	

Table C-16
Replaceable Parts List
Left Panel Fan Assembly, DCR 40-500A1
1058669-2

<u>Symbol</u>	<u>Description</u>	<u>Part Number</u>
B1	Fan, Axial Type	1058664-1
E36	Lugs, Solder	4-111
R10	Res, 12, 225W	27-1075
R11A	Res, 2, 225W	27-1072
R11B	Res, 2, 225W	27-1072
R11C	Res, 2, 225W	27-1072
R11D	Res, 2, 225W	27-1072

Table C-17
Parts Location List
Left Panel Fan Assembly, DCR 40-500A1
1058669-2

<u>Location</u>	<u>Description</u>	<u>Part Number</u>	<u>Symbol</u>
1	Panel, Left Side	1058670-1	
3	Bracket, Resistor	1058617-1	
4	Fan, Axial, 3 Phase	1058664-1	B1
6	Res, 12, 225W	27-1075	R10
7	Res, 2, 225W	27-1072	R11A
	Res, 2, 225W	27-1072	R11B
	Res, 2, 225W	27-1072	R11C
	Res, 2, 225W	27-1072	R11D
10	Washer, Centering	3-412	
11	Washer, Insulating	3-319	
12	Bolt, Thru	1-9077	
13	PHMS, 10-32 X 1/2	6-2000-44	
14	Washer, Lock, #10	6-4012-5	
15	Washer, Flat, #10	6-4000-6	
16	HHMS, 1/4-20 X 3/4	1058421-1	
17	Washer, Lock, #8	6-4012-4	
25	Lugs, Solder,	4-111	E36
28	Insulated Bushing	42-931	
29	Connector Receptacle, Insulated	980759-24	

SERVICE NOTES